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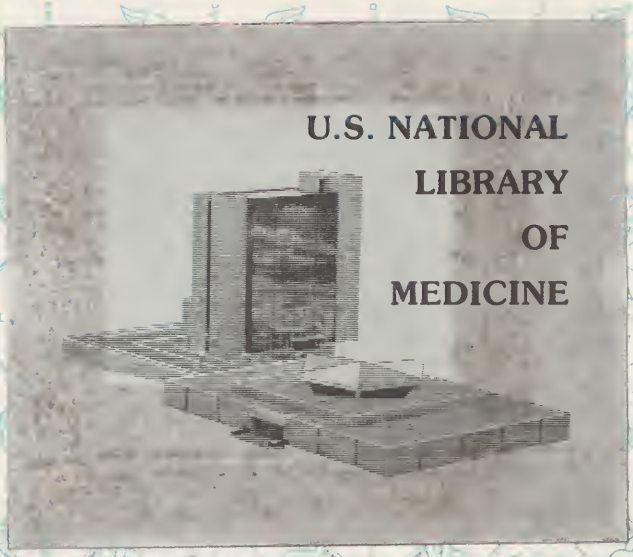

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DOCUMENT SECTION

SCIENTISTS IN UNIFORM

WORLD WAR II

A REPORT TO THE
DEPUTY DIRECTOR
FOR RESEARCH
AND DEVELOPMENT
LOGISTICS DIVISION,
GENERAL STAFF,
U. S. ARMY

WASHINGTON, D. C.
1948

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PREFACE

This study, Scientists in Uniform, World War II, was a cooperative undertaking by the Department of the Army and 31 scientific societies. It began under the general supervision of Lt. Gen. Henry S. Aurand, Director of Logistics, and was completed under the directorate of Maj. Gen. A. C. McAuliffe, Deputy Director for Research and Development, General Staff, United States Army. Dr. David M. Delo, Chief of the Scientific Manpower Section, Research and Development Group, Logistics Division, directed the survey.

Acknowledgement of cooperation and valuable assistance is made to the Executive Secretary or appropriate committee members of the American Chemical Society, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society of Professional Geographers, Geological Society of America, American Association of Petroleum Geologists, American Mathematical Society, Institute of Mathematical Statistics, American Institute of Physics, American Psychological Association, the Division of Biology and Agriculture, and the Office of Scientific Personnel of the National Research Council. Without the cooperation and help of these organizations, this research would not have been possible.

The planning for this study was initiated in 1947 by the members of an informal committee which included A. H. Hausrath, C. V. Kidd, M. H. Trytten, R. M. Emberson, and D. M. Delo.

Much of the work of analysis of the data, their presentation in tabular form, and interpretation of the results, was carried forward by Mr. Eugene Zander and Dr. Paul D. Gard, both members of the Scientific Manpower Section. The actual writing of the report was done by Dr. Delo with editorial assistance from Dr. Gard.

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FOREWORD

Science and scientists are vitally important to modern military functions. Success in any future war will depend as much on the effective use of all the scientific resources of the Nation as upon efficient industrial mobilization or skillful command of the fighting forces.

Scientists constitute an exceedingly small segment of the national population. They compose less than 2 percent of the Armed Forces, but the military functions dependent on their specialized skills and knowledge are highly disproportionate to their numbers. The small numbers involved and the great complexity of scientists' experience and training require the use of special measures to assure their maximum utilization.

This report represents an analysis of the utilization of 15,000 scientists who were members of the Armed Forces during World War II. It is based on a survey made possible through the cooperation of a number of scientific and engineering societies. The results show a definite need for enlargement and continuation of cooperation between organized science and the Armed Forces in planning for effective national defense. Above all, they call for realistic and constructive action within the Military Establishment.

A. C. McAULIFFE,
Major General, GSC,
Deputy Director for Research and Development,
Logistics Division.

434665

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SUMMARY

The Problem

To achieve effective mobilization and use of science[1] and scientists[1] within the Department of the Army.

1. To determine the reliability of statements that large-scale malutilization of scientists by the Armed Forces occurred during the last war.

2. To determine the reasons for malutilization if it occurred.

3. To determine the procedures which should be established to increase the effective use of science and scientists by the Department of the Army.

Investigation of the Problem

Information concerning the military experience of large numbers of scientists was considered necessary if reliable data were to be secured.

The cooperation of organizations representing the nine major scientific and engineering fields listed below was secured (table I, p. 9). They printed and distributed 134,598 questionnaires to their members (see figs. 1 and 2 for examples); 69,350 were filled out and returned; 15,157 of the respondents reported military experience during World War II.

Biology	Geology
Chemistry	Mathematics
Civil Engineering	Physics
Mechanical Engineering	Psychology
Geography	

The replies were analyzed and are summarized in tables II to XVII. In addition, 4,772 of the scientists made suggestions and recommendations of a constructive nature which were examined and classified. (See p. 61.) A number of the more carefully constructed suggestions are included in appendix I.

Statistical results within each scientific field have been returned to each cooperating organization. Each organization is submitting to the Research and Development Group its own recommendations concerning the mobilization and utilization of its members.

[1] Used in this report to refer broadly to the fields of physical and biological science, engineering, and mathematics and to professional workers in these fields.

Statistical Results of the Investigation

1. Of the 15,157 scientists who reported some World War II military service, 609 reported military service in 1947. (See table IV, p. 30.) Of the 9,887 who reported military service as their principal work between 1942 and 1945, 329 remained in uniform in 1947. (See table XII, p. 48.)

2. The 15,157 scientists entered military service in the following ways (table XIII, p. 50):

	Percent
Direct commission	29. 5
Reserve	23. 8
Draft	25. 4
Enlistment	21. 3

3. On the basis of an objective scale of utilization values (table XV, p. 52), technical utilization of the scientists was as follows:

	Percent
Excellent	29. 6
Good	15. 4
Reasonably satisfactory	18. 3
Poor	13. 7
None	23. 0

4. On the basis of method of entry into military service, the percentage of scientists poorly used and unused technically was as follows:

	Percent
Draft	48. 1
Enlisted	44. 2
Reserve	35. 7
Direct commission	22. 7

See table XVI, page 53, for details.

5. The scientists reporting the best technical use while in uniform were psychologists, geographers, engineers, and physicists, in that order (table XV, p. 52).

6. Those most poorly utilized technically were biologists, geologists, chemists, and mathematicians, in that order (table XV, p. 52).

7. Of the 5,283 civil and mechanical engineers who compared their technical use as civilians with their technical use while in uniform, the results are as follows:

	Percent
Excellent:	
Civilian	74. 9
Military	33. 9
Poor and none:	
Civilian	5. 7
Military	26. 5

8. Of the 4,083 recommendations submitted concerning future wartime utilization of scientists by the Armed Services (table XVIII), p. 60).

a. Eighty-one percent recommended improved technical assignment practices and improved supervision of technical functions.

b. Nineteen and one-tenth percent recommended that scientists should not serve in uniform. (For details see pp. 61–68, table XIX, p. 62.)

9. Recommendations by 2,176 were submitted concerning organization or procedures to be used for allocation of scientists in any future wartime situation (table XX, p. 69). Of these—

a. One-tenth of 1 percent recommended continuation of the World War II Selective Service System.

b. Sixty and four-tenths percent recommended some form of national pooling and directed assignment.

c. Thirty-one and two-tenths percent recommended improvements in the Organized Reserve Corps program.

General Conclusions Drawn From the Investigation

1. The absence of special Selective Service procedures for scientists prevented realistic procurement of the kinds and types of these individuals required by the Armed Services.

2. The Organized Reserve Corps program as it applied to scientists was notably deficient (almost 40 percent of those who answered the survey were misused technically).

3. Lack of adequate prewar liaison between science and the services prevented functional understanding of the application of many scientific fields to military activities of a technical nature.

This circumstance also led to misutilization of many scientists and widespread dissatisfaction with service assignment and technical supervision procedures.

4. Assignments to technical positions too often were influenced by rigid physical standards, which in the case of the scientist are normally irrelevant in terms of his competence to perform technical duties.

5. The services had no adequate mechanism for the effective use of professional scientists in the ranks.

CHAPTER 1
UTILIZATION OF SCIENTISTS BY THE ARMED FORCES

Section I. INTRODUCTION AND DISCUSSION

In the war, the laboratory became the first line of defense and the scientist the indispensable warrior. There is no likelihood that this would be changed in event of another conflict.[1]

Experience has demonstrated that scientists are a resource of major national importance. They represent specialized skills and knowledge which are of great value to the Nation's welfare in both war and peace. For this reason, special attention is necessary to insure that their skills are used to the maximum.

This is particularly true today. The tense international situation has many of the features characteristic of a decade ago. We are charting a course at home and abroad which may permanently affect our future as a free Nation. Whether the outcome be peace, war, or a long armed truce, science [2] and scientists [2] will play a vital role.

The mobilization and the ultilization of scientists during any future national emergency resolve naturally into two components: (a) policies and procedures to control and allocate scientific manpower on a national scale, so that all agencies necessary to the war effort receive their fair share of technical personnel; (b) policies and procedures within the National Military Establishment to insure maximum usefulness of the scientists who enter the Armed Services.

Both problems should be of continuous concern to the Nation. It is not enough to wait until hostilities are imminent. Science now plays such a significant role in the economic, social, political, and military strength of the Nation that the means by which it progresses should be subject to constant study. The application of science to the military art, and hence to the defense of the Nation, also should be subjected to continuous and intense scrutiny.

If science is to be applied effectively to military activities during hostilities, it must be so utilized during peace. The mission of the

[1] Report of the President's Scientific Research Board, vol. 1, p. 3, 27 August 1947.

[2] Used in this report to refer broadly to the fields of physical and biological science, engineering, and mathematics and to professional workers in these fields.

Military Establishment during the years of peace is to prepare for effective national defense. Today the tempo of preparation is being accelerated and it is imperative that the contributions of science keep pace.

Numerous plans calculated to enhance the Nations [3] civilian strength in science and scientific manpower recently have been proposed and some are being implemented. As far as is known, attention is not being given to specific procedures and mechanisms for effective mobilization, allocation, and utilization of the Nation's scientific manpower should war come again. *The nature of present planning based on a draft law similar to that of World War II suggests that if war were declared at once, we would utilize much the same methods for this purpose as were used previously.*

The nature of modern weapon development and the exigencies of any total war which may result from current or future international tensions make maximum utilization of *all* phases of technology a necessity for national security. The nature of modern warfare demands that our Armed Forces contain considerable numbers of highly trained scientists, able to function effectively and supported by many more in research laboratories and industry. The *minimum* education of one of these men requires 4 years; by the time a scientist becomes really effective he has expended at least three times this period in education and experience. Experience indicates that there has never been enough scientific manpower to perform effectively all the tasks of national defense during national emergencies.

Scientists have expressed widespread dissatisfaction with the methods used nationally for the allocation of scientific manpower during the last war. Following the sound democratic principle that there should be no favored classes, all citizens became subject to military service. Unfortunately, the Selective Service regulations did not anticipate the role of the scientists—one-half of 1 percent of our population—upon whose shoulders rested a large share of the responsibility for victory or defeat. This situation has resulted in extreme statements by many individuals concerning the malassignment and misuse of scientists in uniform, and the damage done to essential war projects by the unwise drafting of scientists, both trained and in training.

As in the case of any other important national resource, it is necessary that we take immediate steps to plan for the military use of science and scientists. In this process, the first step is the critical evaluation of past procedures. This report represents an evaluation of the utilization of uniformed scientists during World War II upon which recommendations for more effective use may be based.

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[3] Science—The Endless Frontier, by Dr. Vannevar Bush, July 1945; Report of the President's Scientific Research Board (Five volumes), 1947; Report of the President's Commission on Higher Education (Six volumes), 1948.

The National Scientific Component

The number of scientists in the United States has never been accurately determined. The President's Scientific Research Board Report recently gave a national estimate of 137,000 research scientists.[4] During World War II, the National Roster of Scientific and Specialized Personnel listed approximately 400,000 individuals, not all of whom were scientists. The Engineers Joint Council [5] estimates that there will be about 337,000 engineers alone in 1950. Although compilations might be based on the memberships of the individual scientific and engineering societies, they would be inaccurate because many scientists belong to two or more of these societies. In addition, the societies do not include all professional workers in the fields which they represent. For example, the American Chemical Society estimates that its membership includes only approximately 70 percent of all working chemists in the United States. *This absence of an accurate cataloging of scientists is a serious deterrent to realistic planning.*

Although accurate quantitative information is not available, it is evident that the total number of scientists is very small when compared to the total number of men in the working population, that is, ages 18 to 60. A rough estimate would indicate that the scientists comprise less than 2 percent of the male working population.

In terms of men of military age available for service in the Armed Forces, the percentage is no larger. Based on results of this survey, it seems probable that the total number of scientists in uniform during World War II was less than 50,000. When compared with the total of approximately 8,000,000 men in uniform at any one time during World War II, it is apparent that the percentage of the Armed Forces discussed in this report is a very small one. Its importance, however, is highly disporportionate to its size. *Special handling of these individuals to insure that they make a maximum contribution to the entire military effort therefore represents no considerable withdrawal from the stream of men needed for nontechnical combat duty.*

Utilization Survey

In the absence of action by any other agency of Government, the Research and Development Division, War Department General Staff,[6] called a conference in October 1946 to discuss the problem of scientific manpower mobilization. As a result of this meeting, a small informal committee and a number of advisory panels were established to consider the problem. The committee was at no time attached officially to any agency, but continued to function unofficially until March 1948.

In general, the committee hoped to make recommendations which

[4] Report of the President's Scientific Research Board, vol. IV, p. 9, 1947.
[5] The Engineering Profession in Transition, p. 59, Engineers Joint Council, 1947.
[6] Now the Research and Development Group, Logistics Division, General Staff, United States Army.

would lead to more realistic national policies and procedures for the mobilization, allocation, and use of scientific manpower in event of another international emergency. The first logical step appeared to be the evaluation of scientific manpower utilization during World War II, and an analysis of the factors which governed this utilization. It was also planned to study the manpower controls used by other nations; to analyze our own manpower regulations; and to recommend new regulations and procedures to overcome the shortcomings revealed by this analysis. The establishment of the National Security Resources Board has now created an instrument of Government charged with these responsibilities for manpower as a whole.

In order to secure data concerning utilization of scientists in uniform, the Scientific Manpower Branch, Research and Development Division,[7] approached a number of scientific societies to ascertain their interest in a survey to obtain information on this subject. Eventually societies representing nine major fields of science and engineering participated in the survey (table I). Questionnaires (see figs. 1 and 2) were printed and circulated by the societies at their own expense.

Following machine analysis of the responses, each participating society was furnished with detailed statistical tabulations. Each society subsequently prepared a report and a series of recommendations based on these data. The individual reports have been submitted to the Research and Development Group as official statements of policy from the respective societies.

This present volume summarizes and interprets the results of the survey, which was made to determine—

1. The relative degree of proper utilization of scientific manpower in uniform during the war.
2. The reasons for the character of this utilization.
3. The opinions of scientists who had served in uniform as to their professional utilization and their recommendations concerning allocation and use of scientists in any future emergency.

Although prepared primarily from the viewpoint of the Department of the Army, the analysis is based upon the responses of scientists who served in all of the armed services. No attempt has been made to separate these by service. Since it is difficult in a study of this type to separate completely the national aspects of the scientific manpower problem from those peculiar to the National Military Establishment, both are discussed.

Machine analysis of the questionnaires resulted in compilation of a series of statistical tables which are discussed in detail in chapter 2. The more pertinent of these tables, including the constructive opinions of approximately 4,800 of the respondents who experienced military service, are summarized in figures 5 to 8.

[7] Now the Scientific Manpower Section, Research and Development Group.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

WARTIME SERVICE FORM

July 1947

Dear Member: What work did YOU do during the war years? It is vital that we secure the following data from you and all other members to present to government agencies, at their request, so that plans can be made for a more efficient use of scientific manpower in time of national emergency.

C. E. Davies, Secretary

NOTE: PLEASE READ THE ENTIRE QUESTIONNAIRE BEFORE STARTING TO ANSWER IT.

1. Name..... Last First Middle

2. Birth Date..... Month Day Year

3. Residence..... Street Address City Zone State

4. Sex: (Circle one) Male 1 Female 2

5. FORMAL EDUCATIONAL LEVEL: Insert in boxes A and B the appropriate code number from table below, indicating your formal educational level (A) at present, and (B) prior to Feb. 1, 1942.

(A) [ ] (B) [ ]

Basic field	Educational Level				
	Doctor	Master	Bachelor	Incomplete College Training	No College Training
Chemical Engineering	11	12	13	14	15
Civil Engineering	21	22	23	24	25
Electrical Engineering	31	32	33	34	35
Mechanical Engineering	41	42	43	44	45
Mining and Metallurgical Engineering	51	52	53	54	55
Any other Engineering Field	61	62	63	64	65
Any Non-Engineering Field	71	72	73	74	75

6. CIVILIAN EXPERIENCE, if any, during World War II and to date, in Military Departments or War Agencies. Do not include service while in uniform. (Circle only one code no.)

(1) Department, or War Agency, in which you performed your most important war service:

Army Branches

Air Forces	1
Army & Navy Munitions Board	2
Chemical Warfare Service	3
Corps of Engineers	4
Ordnance Department	5
Quartermaster Corps	6
Sanitary Corps	7
Signal Corps	8
Other Army Branches	9

Navy Bureaus

Aeronautics	10
Ordnance	11
Ships	12
Supp. & Accts	13
Yards & Docks	14
Other Navy Bureaus	15
Coast Guard	16
Marine Corps	17
Maritime Commission	18

(2) War Agencies

FEA	19	OSS	25
FWA	20	OWI	26
Lend Lease	21	RFC	27
ODT	22	WPB	28
OPA	23	Other	29
OSRD	24		

(3) Had no civilian experience in a Military Department or War Agency. 30

7. EMPLOYMENT STATUS

(1) General Field of Employment

Insert in each box below the one most appropriate code number from the list of general fields of employment which follows, to indicate your general or principal field of employment (A) at present, (B) between Feb. 1, 1942 and Aug. 15, 1945, and (C) prior to Feb. 1, 1942. (Insert one code number only in each box.)

(A) [ ] (B) [ ] (C) [ ]

Chemical Engineering	1
Civil Engineering	2
Electrical Engineering (incl. Radio)	3
Mechanical Engineering (incl. aeronautical & Industrial)	4
Mining & Metallurgical Engineering	5
Any Other Engineering Field	6
Non-Engineering Field	7

(2) Occupational Status

Insert in each box below the one most appropriate code number from the list of occupational titles which follows to indicate principal occupational status (D) at present, (E) between Feb.1,1942 and Aug.15,1945, and (F) prior to Feb.1,1942. (Insert one code number in each box.)

(D) [ ] (E) [ ] (F) [ ]

Administration-Management, Non-Technical	01
Administration-Management, Technical	02
Analysis and Testing	03
Supervision	04
Consulting, Independent	05
Consulting, as employee of private firm	06
Design	07
Development	08
Drafting	09
Editing and Writing	10
Estimating	11
Inspection	12
Installation	13
Library and Information Service	14
Maintenance	15
Operation	16
Patents	17
Personnel-Labor Problems	18
Production	19
Research in Basic Science	20
Research, Applied	21
Retired	22
Safety Engineering	23
Sales	24
Student	25
Teaching, College or University	26
Teaching, Other	27
Unemployed	28
Any Occupational Status not specified	29

(OVER)

(*Front*)

Figure 1. Questionnaire used by the American Society of Mechanical Engineers.

9. UTILIZATION OF ENGINEERING EXPERIENCE IN CIVILIAN WARTIME EMPLOYMENT ONLY. Answer the following question unless you were a uniformed member of the Armed Forces throughout the period Feb. 1, 1942 - Aug. 15, 1945, in which case circle this number 6

Please check (✓) one of the following to indicate the extent to which your technical and professional training and experience were utilized in your civilian position or positions during World War II:

..... (1) You were utilized in your primary field and at your level of competence (training and experience) throughout most of your civilian employment.

..... (2) You were utilized in your primary field and at your level of competence during at least half of your wartime civilian employment.

..... (3) You were not utilized in your primary field of training and experience, but you did utilize the collateral fields in which you had received training or gained experience.

..... (4) You were utilized in your primary field or in collateral fields for only a relatively short period of your civilian employment.

..... (5) You were utilized in neither your primary field nor in any of your collateral fields in your wartime civilian employment.

14. UTILIZATION OF ENGINEERING EXPERIENCE WHILE IN MILITARY SERVICE DURING WORLD WAR II

Please check (✓) one of the following to indicate the extent to which your technical and professional training and experience were utilized while you were in the military service:

..... (1) You were utilized in your primary field and at your level of competence (training and experience) throughout most of your military service.

..... (2) You were utilized in your primary field and at your level of competence for at least half of the time you were in the military service.

..... (3) You were not utilized in your primary field of training and experience but you did utilize, throughout your service, the collateral fields in which you had received training or gained experience.

..... (4) You were utilized in your primary field or in collateral fields for only a relatively short period of your military service.

..... (5) You were utilized in neither your primary field nor in any of your collateral fields while in the military service.

---

8. SELECTIVE SERVICE EXPERIENCE

Indicate your experience under the Selective Service Act. (Circle only one Code number.)

Selective Service Act not applicable (for age or other reason) . .	10
Registered and:	
Deferred for occupational reasons	11
Deferred for physical reasons	12
Deferred for any other reason	13
Codes 11 and 12 combined.	14
Codes 11 and 13 combined.	15
Codes 12 and 13 combined.	16
Never deferred.	17

15. COMMENT REQUESTED:

If you indicated in question 6 or 11, or both, that you had World War II service in the categories there shown, and particularly if you have indicated in questions 8 or 14, or both, that you believe your engineering qualifications were not used to the fullest practicable extent, it is requested that you comment frankly thereon. (If necessary, use a separate paper and clip same to this questionnaire for return.)

Comment is particularly desired covering the effectiveness of use of your engineering skills in World War II, and your suggestions or recommendations toward bettering the utilization of engineers in preparation for or during a future national emergency of any kind.

ANSWER QUESTIONS 10-14 ONLY IF YOU WERE A UNIFORMED MEMBER OF THE ARMED FORCES DURING WORLD WAR II. (Please answer Question 15.)

10. METHOD OF ENTRY INTO SERVICE: (Circle only one Code no.)

Draft	21	From Reserve or National Guard Status	23
Voluntary Enlistment	22	Direct Commission from Civilian Status. . . .	24

11. ARM OR SERVICE: (Circle only one Code number.)

Army	31	Coast Guard.	34
Navy	32	Merchant Marine.	35
Marines.	33		

12. TOTAL ACTIVE MILITARY DUTY: (Circle only one Code number.)

Less than One Year .	1	Two to Five Years	3
One to Two Years . .	2	More than Five Years. . . .	4

13. EDUCATION IN SERVICE:

While on active duty in military service, did you take any ASTP, Navy-V, or other technical courses?

Yes . . . 1 No . . . 2

PLEASE SEND ANSWERED QUESTIONNAIRE AND COMMENT, IF ANY, BY RETURN MAIL.

(*Back*)

Figure 1. Questionnaire used by the American Society of Mechanical Engineers.—Continued

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
SURVEY OF GEOLOGICAL WORK 1942-1946

(June, 1947)

A careful study is being made of the use of geologists in World War II. The results of this survey will be utilized by the geological societies in their relations with the Federal Government, by the National Research Council, and by the armed services. We feel that this information will contribute materially to better planning for allocation of technical personnel should there be another national emergency. We concur heartily in the need for better planning and urge you to fill out and return promptly this questionnaire.

The Geological Society of America has canvassed its membership and that of associated societies. The A.A.P.G. is co-operating similarly by mailing to its membership and that of the S.E.P.M. Please overlook any duplications that may ensue.

Use enclosed addressed envelope for your return of this sheet.

1. NAME .....

2. ADDRESS .....

3. SEX: Male .....1 FEMALE .....2 DATE OF BIRTH .....
(Circle one and only one of these two code numbers)

4. FORMAL EDUCATION IN GEOLOGICAL SCIENCES: Indicate below the highest educational level reached by you in geological sciences (exclude honorary degrees)

	Doctor	Master	Incomplete Grad Tng	Bachelor	Incomp. Col Tng	No Col Tng
Geological sciences	1	2	3.	4	5	6

(Circle one and only one of these six code numbers)

FORMAL EDUCATION IN A NON-GEOLOGICAL FIELD: If you received education in a field other than geology, circle below the highest education level reached by you (exclude honorary degrees).

Doctor .....1 Master .....2 Bachelor 3
Incomplete college .....4 None 5

5. FORMAL EDUCATION SINCE FEBRUARY 1, 1942: Circle appropriate numbers for education received since Feb. 1, 1942:

Doctor .....1 Bachelor .....3 None 5
Master .....2 College work—no degree 4

6. EXPERIENCE:

a. Present work status: (Circle one)

College or university 1
Economic geology (non-gov't) 2
Student 6
Present annual salary $.....
(reply optional)
Gov't or state agency (name) 4
Military service 5
Unemployed 9
Retired 8

b. Principal type of work in which engaged between Feb. 1, 1942 and Sept. 1, 1945:
(Circle only one)

College or university 1
Gov't or state agency 2
Economic geology (non-gov't) 5
Student 6
Military service 7
Retired 8

c. If, during the period Feb. 1, 1942 to Sept. 1, 1945, you engaged in work you consider to be significant, in addition to that indicated in 6(b), circle one of the following:

College or university 1
Gov't or state agency 2
Student 6
Economic geology (non-gov't) 5
Military service 7

d. Principal experience prior to February 1, 1942:

Name of Organization	Inclusive dates	Descriptive title of work

e. Experience from February 1, 1942 to date:

Name of Organization	Inclusive dates	Descriptive title of work

(Over)

(*Front*)

Figure 2. Questionnaire used by the American Association of Petroleum Geologists.

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f. Countries, states, provinces, Departments or Territories outside Continental U.S. in which Geological work has been done since 1942:

Political Division or Sub-division	R (Reconnaisance) D (Detail)	Type of Geol. work pursued i.e. structural	Nos. Mos. Spent	Local Language learned (yes - no)

g. If now a student; state courses, degree anticipated and length of time you expect to continue your studies:

h. Specific experience, if any, as civilian with Military Depts. (Scientific Consultant, Technician, Technical Representative; etc.) Specific branch of service (SigC, QMC, etc.) and include comments decmed desirable (use separate page if necessary).

7. SELECTIVE SERVICE EXPERIENCE:

a. Indicate your draft history since the passage of the Selective Service Act by circling the number for all items which have at any time applied in your case.

1.....Deferred for occupation
2.....Deferred for physical reasons
9.....Deferred for age
3.....Deferred for any other reason
9.....Never deferred

IF YOU WERE NOT IN THE ARMED SERVICE, DO NOT ANSWER THE REMAINDER OF THIS QUESTIONNAIRE

8. METHOD OF ENTRY INTO SERVICE: (Circle one)

Draft 1
From Reserve 3
Voluntary Enlistment 2
Direct Commission 4

9. ARM OF SERVICE: (Circle one)

Army 1
Navy 2
Marines 3
Coast Guard 4
WAC 5
WAVE 6
SPAR 7
Merchant Marine 8

10. a. Date of entry into Service.....Rank.....

b. Length of Service.....years.....months, rank at discharge.....

11. EDUCATION IN SERVICE:

a. Did you take any ASTP, Navy V or other technical courses during Service?
Yes.....1 No.....2
(Circle one and only one of these two code numbers)

b. If yes, list, give approximate time in attendance, official designation of course and institution.

12. NATURE OF MILITARY SERVICE: Summarize all assignments with approximate dates, indicating whether or not your professional training and experience were utilized to any extent. If not well utilized, give reasons.

13. COMMENTS ON YOUR MILITARY SERVICE WITH REFERENCE TO:

a. Effectiveness of your geological work in World War II.
b. Suggestions for better utilization of geologists in national emergency.

(*Back*)

Figure 2. Questionnaire used by the American Association of Petroleum Geologists.—Continued

Table I. Questionnaire Coverage and Returns from Nine Major Scientific Fields

Scientific Field	Number of Questionnaires Sent	Number of Questionnaires Returned	Percent Return	Number with Military Service	Percent of Those Making Returns Who Had Military Service
Biology	24, 258	10, 071	41. 5	2, 542	25. 2
Chemistry	48, 000	30, 417	63. 4	4, 506	14. 8
Engineering, Civil	18, 000	7, 610	42. 3	3, 242	42. 7
Engineering, Mech	18, 000	5, 802	32. 2	2, 041	35. 2
Geography	1, 800	550	30. 6	111	20. 2
Geology	7, 100	3, 142	44. 3	605	19. 3
Mathematics	4, 000	1, 428	35. 7	317	22. 2
Physics	8, 440	6, 330	75. 0	623	9. 8
Psychology	5, 000	4, 000	80. 0	1, 170	29. 3
Total, All Nine Fields	134, 598	69, 350	51. 5	15, 157	21. 9

Figure 3 shows the total number of questionnaires distributed, the number returned, and the number of respondents who experienced military service. The major participating fields, with number of questionnaires mailed and total returned, are given in table I.

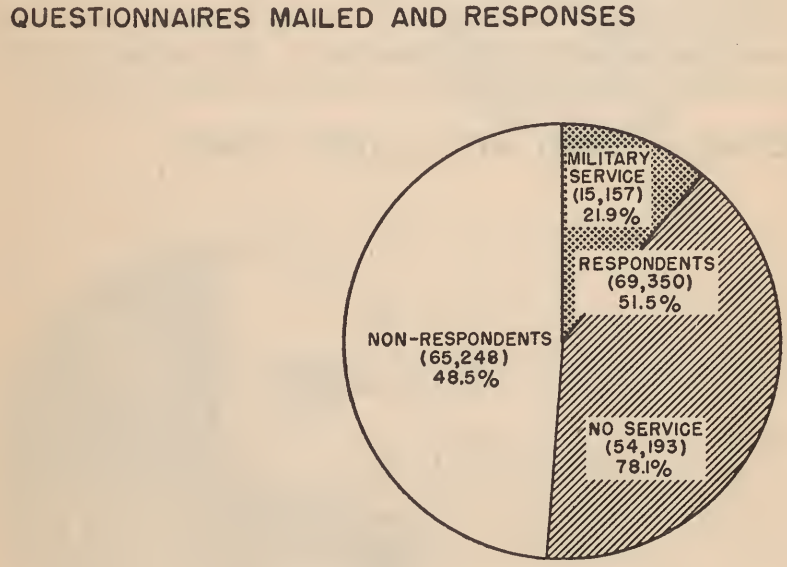


Figure 3.

Figure 4 summarizes the distribution by scientific field of the 15,157 scientists who reported military service. Approximately one-third were civil and mechanical engineers; approximately one-third were

chemists; the remainder were distributed irregularly throughout the other six basic fields of science.

SCIENTIFIC FIELDS OF MILITARY RESPONDENTS

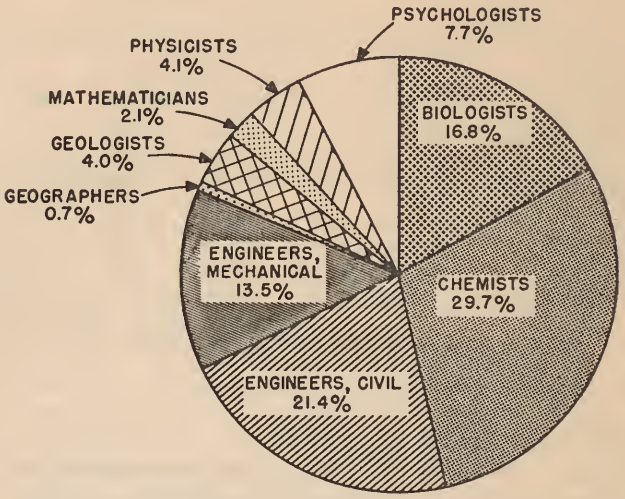


Figure 4.

The method of entry of these scientists into the Armed Services is shown in figure 5. It is noteworthy that the largest single category of entry was by means of direct commission. The second largest was by means of the draft and the third from the Organized Reserve.

METHOD OF ENTRY INTO MILITARY SERVICE

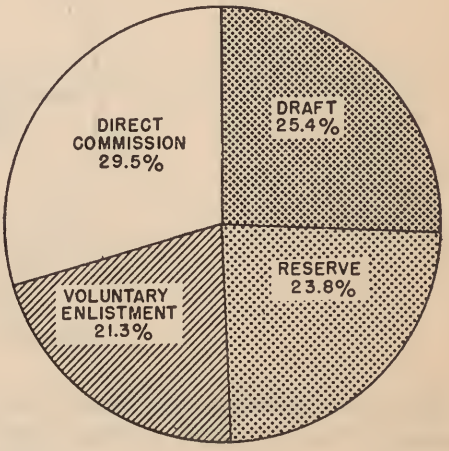


Figure 5.

Figure 6 represents a summary of the reported utilization of scientists in uniform according to the rating scale given below in table II. Individual ratings in six of the basic science fields were determined as objectively as possible from the nature of the respondent's military assignments. Utilization ratings in the engineering fields and psychology were determined by the individual respondents from tables on the questionnaire. The percentages given in figure 6 are therefore subject to some doubt as to narrow accuracy, but appear to be *relatively* reliable.

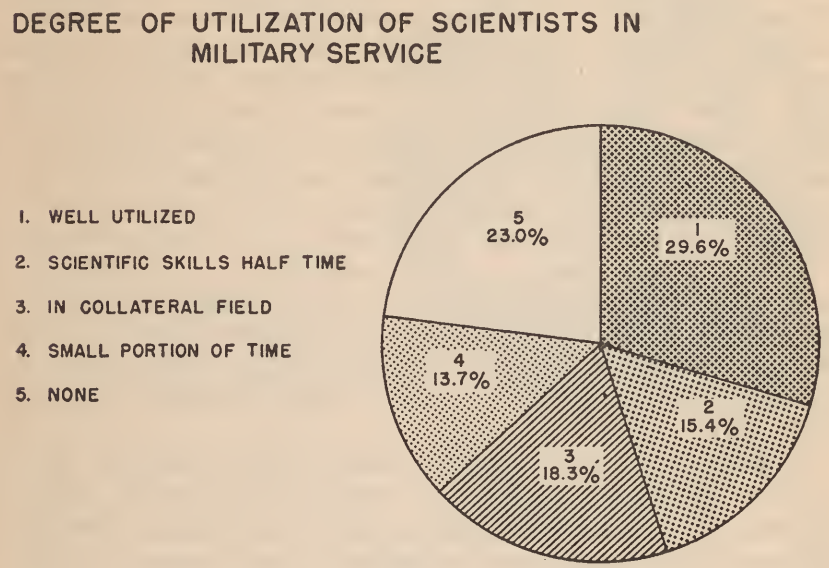


Figure 6.

Table II. Utilization Categories and Their Definitions

Category Number	Definition
1—Excellent	Utilized in primary field and at proper level of competence (training and experience) throughout most of military service.
2—Good	Utilized in primary field and at proper level of competence for at least half of the time in military service.
3—Reasonably Satisfactory.	Not utilized in primary field of training and experience but did utilize, throughout military service, the collateral fields in which the scientist had received training or gained experience.
4—Poor	Utilized in primary field or in collateral field for only a relatively short period of military service.
5—None	Utilized in neither primary field nor in any of the collateral fields while in military service.

It is realized that there was an insufficient number of available specialized positions in the Services to utilize the highest competence of all the scientists supplied by the various procurement methods. Thus categories 1, 2, and 3 are considered to represent a relatively satisfactory utilization since even No. 3 utilized at least some of the individual's technical background. Categories 4 and 5 represent ineffective and negative use of the scientist's technical competence.

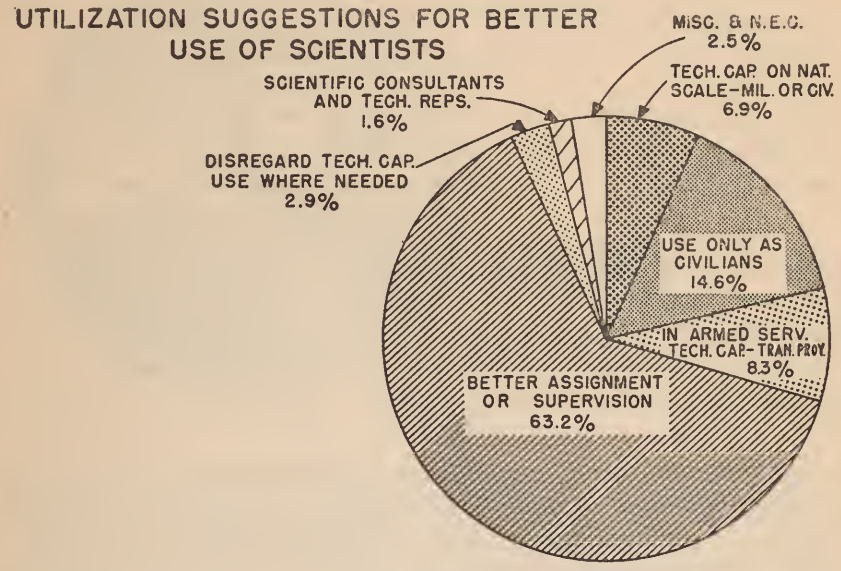
Analysis (table XVI, p. 53) also indicates that a respondent who was drafted or who voluntarily enlisted had two chances in ten of utilizing his technical background at his level of competence during his military service. A Reserve officer had three chances in ten of utilizing his full skill. Scientists who entered the Service by means of a direct commission had four chances in ten of being used with full effectiveness. When these conclusions are viewed in the light of the widespread technical training and educational programs supported by the Services during the war, it is apparent that personnel procurement, classification, allocation, and management methods left much to be desired. This could not fail to be costly to the national wartime effort in time and money, as well as inhibitory to the efficiency of technical military activities. IF THE AVAILABLE SCIENTISTS WERE NOT FULLY UTILIZED IT IS QUESTIONABLE IF THE FIELDS OF TECHNOLOGY WHICH THEY REPRESENTED WERE APPLIED EFFECTIVELY TO THE PROSECUTION OF THE WAR.

An attempt is also made to compare wartime technical use of scientists in civilian employment with their utilization while in uniform. The questionnaires answered by the civil and mechanical engineers bore identical category tables for both modes of employment. These were checked by the individual respondents. The results indicated good utilization (categories 1 and 2 of table II) of 86 percent of the engineers while employed as civilians; for those in military service the comparable figure was 50 percent. If the first three categories were used for comparison, the civilian percentage was 94 percent; the military percentage was 73½ percent. Further discussion to this point is contained in chapter 2, page 25.

In addition to the information given in the preceding figures concerning utilization and entrance into the Services, approximately one-third of the scientists who experienced military service gave constructive suggestions or comments concerning better technical utilization, or recommended organization and procedures for better allocation in event of another emergency. These are summarized in highly simplified form in figures 7 and 8.

Most significant in figure 7 is the large percentage of scientists who recommended that better assignment procedures and more effective technical use and supervision of their work would have been desirable. A second major category of opinion reveals that a considerable number

of these men feel that scientists should not enter the Armed Services during a period of emergency but should work entirely as civilians. It is believed that this attitude was expressed primarily by scientists who were not utilized effectively during their military service.



Mil. or Civ	Military or civilian.
Misc. and N. E. C	Miscellaneous and not elsewhere classified.
Nat	National.
Tech. Cap	Technical capacity.
Tech. Reps	Technical representatives.
Trans. Prov	Transfer provisions.

Figure 7.

Five significant conclusions may be drawn from figure 8. First, a universal dissatisfaction with the operations of the Selective Service System as it relates to scientific manpower is clearly indicated by the fact that only 0.04 percent of nearly 5,000 scientists recommended its retention. Second, the scientists strongly recommended some type of national agency to allocate and assign scientific manpower. They suggested the establishment of an improved national roster of scientific and technical personnel, use of the technical societies, or universal national service legislation. Third, there was a strong plea for the establishment of a more effective Reserve program to consist of peacetime training for possible mobilization assignments and a shifting of scientific personnel into branches of service more appropriate to their professional and technological training. Fourth, there was a considerable body of opinion which urged the direct commissioning of all technical and scientific personnel and the assignment of a rank appropriate to the competence, training, and experience of each person recommended. Finally, a considerable number

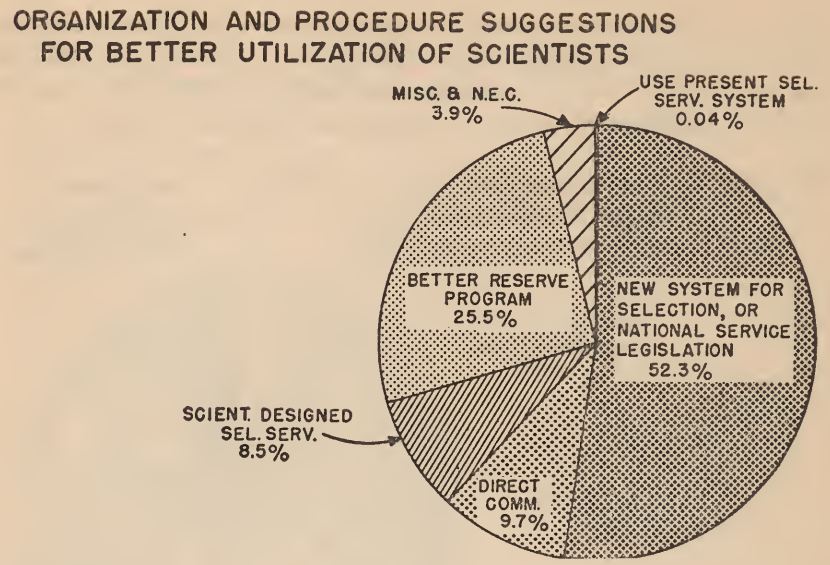


Figure 8.

of these scientists urged a modification of Selective Service to make it really scientific. This recommendation corroborates the first conclusion mentioned above, and is perhaps closely related to the second opinion in which some type of a new selection system is suggested.

Section II. GENERAL CONCLUSIONS TO BE DRAWN FROM THE SURVEY

The conclusions given below were drawn from the statistical results of the survey, from the recommendations of the individual respondents, and from conversations with many scientists who engaged in wartime research and development activities.

1. Many outstanding scientists assert that the assignment of scientists under the Selective Service System was wasteful of scientific manpower because of the absence of scientific selective procedures. An undesirable onus was placed on the individual scientist who was deferred for important research and development work because the concept of a scientific selectivity was not understood or popularly accepted.

Deferment procedures are reported to have required the expenditure of much valuable time of busy scientific administrators in order to prevent the drafting of necessary scientific manpower away from essential war projects. Their efforts were by no means completely successful.

Many of the young scientists who did not enter a uniformed service during the war when their work was considered to be essential to effective prosecution of the war effort were drafted after VJ-day and spent considerable periods as enlisted men. The evidence at hand indicates that in general they were not effectively utilized. Scientists assert that there is a widespread feeling among the younger scientists that in event of another emergency they will not subject themselves to the social and other pressures and to the uncertainties which resulted from their deferment during World War II, but will enter the armed services voluntarily in large numbers, probably to the detriment of the over-all war effort.

2. The Organized Reserve Program, insofar as it affected scientific manpower, was notably deficient.

The opinions of considerable numbers of scientists who entered active service through the Organized Reserve Corps are indicative of the shortcomings of the prewar system (table XVIII, p. 60). The fact that statistically the utilization of Reserve officers in their technical capacities was no better than the average of all methods of entry into the service (see fig. 5) points to the same conclusion.

Widespread dissatisfaction also has been expressed by Reserve officers because direct commissions were allocated to their scientific colleagues in higher ranks than they themselves enjoyed, although they had participated in Reserve affairs over a long period of time. Furthermore, there was a tendency to call first the Reserve officers who could be spared readily by their employers. By the time the more valuable members of an organization were called to duty the former officers had gained rank, and in many cases those with less technical competence but with higher rank supervised their scientific superiors to the detriment of the technical programs of the services.

3. Scientists trained in technical fields whose uses were not thoroughly understood by personnel of the armed services tended to be poorly utilized; the opposite was generally true for scientists representing technologies with which the services were familiar.

The services have long been familiar with the applications of engineering to their needs and with the use of some basic fields of science, notably chemistry. Early in the war it became apparent that physics and psychology were to be of key importance; the former because of its applications to radar and electronics in general; the latter because of the necessity for the classification of millions of men.

On a comparative basis physicists, engineers, and psychologists report good utilization. By contrast, such fields as geology and biology were less well understood by the services, and were not as well used. Experience has subsequently demonstrated their numerous applications to military activities. The better utilization of physics and psychology was also aided by the specific efforts of the National Research Council and the American Psychological Association, which obtained the transfer of considerable numbers of physicists and psychologists who had originally been misassigned.

4. Failure to understand the application of many technical fields to military functions led to a lower efficiency of technical military activities and an inability of scientists to carry projects through to active military application.

The absence of close liaison between the services and the world of science between the wars meant that many key military positions of a technical nature reportedly became filled by men without appropriate scientific background. It was not surprising, therefore, that the services tended to utilize procedures and methods which they knew were fairly effective and were loath to use new and untried technical procedures proposed by scientists who lacked military experience. There was also a tendency to place the research-minded man at a fairly low echelon where his influence was not great. In order to secure technical action, he was required to convince his superiors of the need for new procedures. Often his technical arguments could not be understood by the supervisor who lacked comparable technical training. Hence, much technical work was carried on but never applied effectively to military activities.

5. Large numbers of scientists who could have been used effectively by the military services in their fields of specialization were given nontechnical assignments because established manning and organizational requirements did not demand the number of technically trained personnel who were actually called for military service.

Many respondents to the survey indicate that upon induction they were placed in combat units and informed that there was no need for men with their technical qualifications. In many cases these same men were needed either in another branch of the same service, in one of the other services, or in civilian agencies such as OSRD which were engaged in technical work specifically supporting the services.

Needs changed considerably as the war progressed, and oft-times the induction centers could not keep abreast of the changes in requirements. Thus, they often failed to assign inducted scientists to technical jobs when at the same time the Services were seeking technical assistance and personnel from civilian agencies.

6. Scientists express great dissatisfaction with assignment and classification procedures as they were applied to the professional scientists in uniform.

This dissatisfaction is brought out very clearly in the summary of the opinions of respondents to this survey discussed in chapter 2, p. 25. More than half of all the scientists who ventured constructive opinions recommended better assignment and classification procedures for technical personnel. They specified in particular the need for better placement in terms of technical competence and the necessity for supervision by men as well trained technically as themselves. These comments came from both Reserve officers and those who entered the Services by other means.

Apparently one of the major circumstances which caused dissatisfaction was the classification and assignment of professional technical personnel by persons who lacked the necessary technical background. Another factor was the concept that an officer could be rotated from job to job and be uniformly effective in all of them. Although necessary for officers expected to occupy a variety of administrative or command positions, this practice is indefensible when applied to positions which require a professional technical background.

7. Assignments too often were influenced by physical fitness, which in the case of the scientist is often irrelevant to his competence to perform technical duties.

It is apparent that the physical standards were such as to prevent the commissioning of many scientists with minor physical disabilities, otherwise perfectly able to perform noncombat duties effectively. The governing factor was the use of the same physical standards both for officers who served in the zone of interior and for those who were expected to perform combat duties. Thus, able-bodied officers were kept in noncombat installations when they could readily have been placed in other assignments where they were needed. They easily could have been replaced by men who were fully as competent technically even though they had slight physical disabilities. It is true that the waiver system is designed to cope with this situation, but unfortunately it was not utilized to the extent necessary to prevent a relatively large loss of the technical capabilities of professional scientists who were in uniform.

8. The Services had no adequate mechanism for the effective utilization of professional engineers and scientists who remained in the ranks.

It is obvious that an enlisted man, except under highly unusual conditions, cannot exert appropriate influence to secure the adoption of his technical proposals by the officers under whom he is serving. The very nature of the military organization places the command function in the hands of the officer and *rightly so.* An enlisted man has a long chain of command between himself and a project supervisor and this chain of command is very likely to contain individuals who do not possess the technical background of the professional scientist. Furthermore, there is a tendency to utilize the enlisted man wherever a pair of hands may be needed and without regard to the fact that he may be highly competent in a particular field.

One method which was utilized in an attempt to solve this problem was to assign enlisted men back to laboratories where they worked alongside their former colleagues who were still in civilian clothes. This created a serious morale problem, since the enlisted man was subject to military discipline and was receiving a much lower salary than the civilian.

Another approach to better use of the scientifically trained enlisted man was made by the War Department. It established a Technical Detachment in September 1944 through which scientists at the enlisted level were assigned in accordance with the technical requirements of the Department. Approximately 2,000 scientists were classified and assigned to technical military duties through this Technical Detachment prior to its dissolution in April 1947.[8]

[8] "Scientific and Technical Enlisted Men in the Army," Marsh W. White, Scientific Monthly, vol. 67, No. 1, pp. 47–49, July 1948.

Section III. GENERAL CONDITIONS WHICH INFLUENCED ALLOCATION AND UTILIZATION OF SCIENTISTS DURING WORLD WAR II

1. There had been no effective prewar planning for the allocation and use of our national scientific manpower resources.

Existing regulations would have made it possible to allocate the national scientific manpower resources more realistically. Unfortunately, realization of their importance to the war effort came too late to mitigate the difficulties which arose. Thus, no special procedures were set up under the Selective Service System, and it failed to cope effectively with scientific manpower procurement.

2. There was a general lack of detailed knowledge on the part of both civilian and military organizations as to the importance of technology to warfare.

The absence of specific and continuous liaison between the sciences and the Services before World War II led to a lack of appreciation by *both civilian and military components* of the military applications of technology and a failure to use either science or scientists to the best advantage.

3. Political and social pressures tended to drive many scientists into uniform unnecessarily.

It was often difficult for the general public to understand why able-bodied scientists were not in uniform, and the secret nature of many research programs prevented adequate explanation. This sometimes led to local resentment and the feeling that the scientist was dodging his responsibilities as a citizen. The very short deferment periods and the constant pressure for the scientists to don a uniform also adversely affected scientists' morale. Even in laboratories, performing essential services for the Armed Forces, there was a constant pressure to force the younger scientist into Service. In some of these laboratories, such as the Radiation Laboratory at Massachusetts Institute of Technology, almost all of the men were young, because the radar field was a new one and only the young men were experienced in it. This was true in other laboratories as well. *BECAUSE THEY DID NOT SERVE IN UNIFORM, NONE WAS CONSIDERED TO HAVE OFFICIALLY PERFORMED HIS WARTIME RESPONSIBILITIES DESPITE HIS IMPORTANT CONTRIBUTIONS TO THE TECHNICAL WAR EFFORT.*

4. Numerous changes in Selective Service operations and emphasis were caused by unanticipated manpower needs of the Armed Services during the course of the war.

These resulted in part from the lack of realization of the role which scientists and their work were to play in warfare. Hence, Selective Service policies were changed frequently, resulting in a constant sense of unease among civilian scientists of draft age, and a recurrent necessity for their employers to present new evidence to the Selective Service System to prevent drafting of these personnel.

5. The organization and the assignment practices of the Armed Services originally were based on the prewar policy of officer competence in any field.

In the small pre-World War II services, advancement was based on competence in various aspects of the service and an officer was rotated from job to job to give him broad experience. It is a sound concept in positions primarily administrative in nature, or of the type involving command functions. This procedure not only is unwise but wasteful and inhibitory of efficiency when applied to positions which are primarily technical in nature, where efficient performance depends on a specific technical background. Certain functions of the Armed Services have now become almost entirely subject to the technical competence of the participating individuals. If the missions of these portions of the Services are to be accomplished, and in this accomplishment they are to utilize all the technological resources available to them, the operating and supervisory positions must be filled by men who are completely qualified.

6. Concurrent with the inadequacy of national planning there was an enormous and rapid expansion of the Services, and a necessity for the large-scale development of personnel classification and assignment systems.

Time did not allow the adequate training of a sufficient number of competent interviewers and classification analysts to cope effectively with the large numbers of men who were classified and assigned.

7. Scientists who entered the military service were subjected to a requisition system of assignment at military reception centers which prevented pooling of technical manpower for future specific assignments in accordance with Service requirements for men with their education and skills.

Interviewers at reception centers were seldom trained in science or engineering and often were unable to evaluate adequately the skills of drafted or enlisted scientists.

8. The development of many new technical devices used by the Services during World War II led to repeated calls on the scientists remaining in civilian life. At the same time, many were already filling nontechnical positions in the Services and readily could have been transferred.

As radar and other new devices became available during the war, it became necessary for the services to secure experts for training programs, for maintenance, and for operation. Again, rather than transfer scientists from technical positions of low priority or from nontechnical positions, repeated calls were made on the scientists remaining in civilian life. This finally led in the Office of Scientific Research and Development to the establishment of an office [9] specifically designed to lend scientists to the armed services for short-term jobs connected with installation, testing, and training in the operation of these new instruments of warfare. Despite the fact that many of these men were in uniform working with and for the services, they were still subject to draft calls and many of them were with difficulty maintained in this function. This was likewise true for scientists from other organizations who were working directly with the services, often in combat areas.

[9] Combat Scientists, by Lincoln R. Thiesmeyer and John E. Burchard, Little, Brown & Co., Boston, September 1947.

Section IV. RECOMMENDED ACTIONS

Introduction

Policy, organization, and procedures which will lead to equitable allocation of the scientific population on a national scale will be necessary for the effective prosecution of any future war.

Numerous facets of the national scene must be considered.

First and foremost, the Military Services must be supplied with an adequate number of professional scientists and engineers, both civilian and uniformed, to perform their technical missions.

Second, adequate numbers of physicians and supporting personnel such as radiologists, bacteriologists, and sanitary engineers, must be reserved in civilian status to maintain the national health.

Third, a sufficient number of civilian engineers and scientists must be assigned to operate communication and transportation systems, and light-and-heat facilities.

Fourth, industry must utilize scientific manpower to carry on research, development, testing, and production to support the war effort and the civilian economy.

Fifth, various nonmilitary governmental agencies must continue their scientific activities.

Sixth, educational activities must be continued on a reduced but significant scale so that we do not sacrifice the long-range welfare of the country to short-range needs.

In all of these, scientists are indispensable.

The activities of any war period make unparalleled drains on the technical economy of the nation. Great care must be taken, therefore, to mobilize the national scientific resources in such a way that they make the greatest contribution possible to the war effort. It is essential, in accordance with general policy decisions reached at the highest levels of government, that procedures be devised which will insure the effective distribution of scientists to all categories of the national economy. Hand in hand with this procedure, it is imperative that the users of these personnel, that is, industry, education, the Armed Services, etc., utilize the greatest care to insure that their supply of scientists reaches as far as possible in the same way that they would conserve any other valuable and scarce resource.

Discussion

The survey upon which this report is based shows that the procedures utilized for the mobilization, allocation, and use of scientists

during World War II possessed many shortcomings. There appear to have been three major inadequacies—

1. A lack of adequate planning on a national scale.
2. The wrong type of national allocation procedures for scientists.
3. Inadequate means for classification, assignment and use of scientists within the Armed Services.

To overcome these deficiencies, it would seem reasonable to use the same general approach now being applied to planning for the mobilization and use of industrial facilites or for estimating our resources of strategic minerals.

The enormous expansion of research, development, and other technical activities in the United States within recent years has led to an unprecedented demand for scientists. Owing to our unrealistic draft policies during World War II and the present large demand for trained scientists, we still have severe shortages in some fields. However, the return of large numbers of veterans to college enhanced by resumption of the normal flow of college students is now leading to the graduation of large numbers of scientific students from colleges and universities. Dependent on the requirements of industry and the Armed Services, the shortages in many fields should be eliminated by 1951.

Even though we can prophesy the approximate output of trained men in the next 3 years, we have no means of making realistic national estimates of our future requirements for scientific manpower. For all we know at present, the year 1955 may find some fields oversupplied and others held back because of manpower shortages. There is no central place where information concerning the plans of industry, the needs of our growing populace, or the potential requirements of the Military Establishment can be focalized at the operational level. In order to plan realistically for either future war or future peace, it seems necessary to establish a national mechanism which will be able to evaluate *present and potential supply in terms of present and potential demand.*

As an adjunct to such an office, a catalog of scientists appears to be necessary. Since the various scientific and engineering societies are most familiar with the personnel in the field which each represents, these societies appear to be the logical agents for this task.

If we expect to utilize scientific manpower in any future national emergency as realistically as we plan to use industrial facilities, we cannot expect to allocate them by lot, age group, or local bulk quotas. It would seem more realistic to make every working scientist responsible for service in the national interest no matter what his age or physical constitution. The scientific manpower pool then could be distributed by the central office which already possesses adequate information concerning the national supply, to either military or civilian agencies in accordance with requirements. This procedure

should supply the Military Establishment with the numbers and kinds of scientists required for all types of military activities at the times when they are needed.

The second segment of the problem applies to the use of uniformed scientists by the National Military Establishment during a period of hostilities. Military activities requiring a technical background for their adequate performance have become of great importance to the effective functioning of the combat arms, and in many cases scientists form a part of the combat team. In addition, a wide variety of supporting technical activities which require a professional level of training and experience are now necessary in the noncombat agencies of the services. These may include such widely varied activities as research and development, operations research, combat evaluation of new devices, or the maintenance of communicatons.

It is to the advantage of the services to apply the most modern advancements in technology to their combat and noncombat functions. This will require that the applications of known technology to military activities be constantly scrutinized. This process is basic to improvement in technical functioning and to proper use of scientific personnel resources. Once the applications of science and engineering have been determined, the role of the scientist or engineer has been defined. It then remains to establish processes to identify, evaluate, and assign the scientist to the job his technical competence fits best. In order to do this effectively, it would seem appropriate to establish an office within each of the departments of the National Military Establishment, specifically empowered and staffed to carry out necessary scientific manpower research, planning, and operations. Under the principle of unification, the activities of these offices could be coordinated and broad policy delineated from the level of the Secretary of Defense or the Research and Development Board.

CHAPTER 2

ANALYSIS OF DATA AND CONSTRUCTIVE SUGGESTIONS AND RECOMMENDATIONS OF SCIENTISTS

Section I. INTRODUCTION

The following section of this report represents a detailed analysis of the summarized statistics resulting from machine analysis of 69,350 questionnaires.

Societies representing nine major scientific fields participated in the survey. Cooperation of the Division of Biology and Agriculture and the Office of Scientific Personnel, National Research Council, made possible the survey of 21 individual societies in the field of biology. In all other cases, contacts were made direct with the executive secretaries or the councils of the cooperating societies.[1]

The original questionnaire was circulated by the American Chemical Society. Representatives of the Society, the Department of the Army, Department of the Navy, and the National Research Council participated in its preparation. The seven basic science fields all used a comparable questionnaire with only minor variations (fig. 2). The two engineering societies used a different form (fig. 1) which did not yield exactly comparable data except in the areas of education and military experience.

The survey was primarily a cooperative venture. The societies printed and circulated the questionnaires at their own expense. In return they received analyses of the information submitted by their respondents. The questionnaires remain the property of the societies.

Arrangements had been made initially with the National Roster of Scientific and Specialized Personnel to perform the IBM analysis of the questionnaires. Reduction in budget during 1947 forced discontinuance of this arrangement after 26,000 questionnaires had been processed. At this time the Director [2] of Research and Development obtained the cooperation of The Adjutant General, and most of the remaining questionnaires were tabulated by the Strength Accounting

[1] See table I for complete list and appendix II for names and addresses.

[2] Then Maj. Gen. Henry S. Aurand.

Branch, AGO.[3] Those from the American Psychological Association were processed by the Bureau of Labor Statistics, Department of Labor,[4] and the Office of Naval Research analyzed those from the American Institute of Physics.

The statistical tables on which this report is based were prepared in the Scientific Manpower Section, Research and Development Group, Logistics Division, General Staff. In addition to the statistical analyses, all constructive opinions offered by respondents to the open-type concluding questions of the questionnaire were summarized. An individual report has been prepared for each scientific field—in some cases by the staff of the Scientific Manpower Section, in others by committees representing the individual societies. Regardless of who prepared it, each individual report has been analyzed and approved by the appropriate society, and submitted to the Research and Development Group, GSUSA, as the official expression of the society. Allowing for overlapping membership, it is estimated that the several reports collectively represent about 130,000 American scientists.

[3] Particular thanks are due to Col. Norman A. Donges and Mr. Finley N. Middleton for their cooperation which made possible the tabulation of the remaining 108,000 questionaires.

[4] The Department of the Army is indebted to Mr. Joseph Drager, Chief, Machine Tabulation Division for the assistance provided by the Bureau of Labor Statistics of the Department of Labor.

Section II. WHAT THE SURVEY REVEALED

Introduction

Chapter 1 summarized very briefly and in *general terms* the statistical results obtained by the survey. Chapter 2 deals with the total results in much greater detail. Much the same kind of analysis is used in each of the nine individual reports from the cooperating societies.

Coverage and Returns

Complete data concerning the percentage of scientists and technologists of the United States who experienced military service during World War II are not extant. It is estimated that the percentage figures in table III, which show the percent of respondents with military service, are somewhat in excess of the national average by approximately 25 percent. A recent study by the Engineers Joint Council [5] based on 47,000 respondents (52 percent of circularization) revealed that 12 percent reported military service at some time during the war. The American Association of Petroleum Geologists, in a study published in 1947,[6] reported that 746 (14.9 percent) of its 5,000 members served in the Armed Forces. The percentage of respondent psychologists in uniform was 23.4 percent of those to whom questionnaires were mailed. It is obvious that the sample return from engineers who responded to the present survey was weighted heavily in the category of those who saw service during the last war. On the other hand it is also well to note, in drawing conclusions from these data, that the societies for the most part include the more mature members of the professions, so that younger men as a class are by no means as well represented as are those with more professional experience and greater age. Age was an important factor in connection with entrance into the armed forces.

Regardless of the narrow accuracy of the actual percentages given in comparison with the nation's total scientific manpower, it is considered that the sample of 69,350 respondents, 15,157 of whom were in uniform, represents a *valid sample* from which *qualitatively accurate conclusions may be drawn.* The reader is asked to bear this in mind throughout the report.

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[5] The Engineering Profession in Transition—published by the Engineers Joint Council, 1947.

[6] Report of the National Service Committee, American Association of Petroleum Geologists, AAPG Bulletin, vol. 31, No. 5, pp. 887–893, 1947.

Table III. Questionnaire Coverage and Returns from Eight Major Scientific Fields and Their Respective Disciplines

Scientific Fields and Disciplines	Number of Questionnaires Sent	Number of Questionnaires Returned	Percent Return	Number with Military Service	Percent of Those Making Returns Who had Military Service
BIOLOGY:					
Agronomy (American Society of Agronomy); (Soil Science Society of America)	1, 750	655	37. 4	115	17. 6
Animal Production, American Society of	803	306	38. 1	63	20. 6
Bacteriologists, Society of American	3, 000	1, 098	36. 6	318	29. 0
Biological Chemists, American Society of	1, 000	363	36. 3	22	6. 1
Dairy Scientists (American Dairy Science Association)	1, 700	600	35. 3	110	18. 3
Development and Growth, Society for the Study of	250	102	40. 8	8	7. 8
Ecology (Ecological Society of America)	700	214	30. 6	40	18. 7
Entomology (The Entomological Society of America); (The American Assn. of Economic Entomologists)	1, 400	807	56. 7	242	30. 0
Foresters, Society of American	5, 000	2, 200	44. 0	875	39. 8
Genetics, Society of American	150	66	44. 0	17	25. 7
Horticulture (American Society for Horticultural Science)	1, 200	445	37. 1	94	21. 1
Limnology (Limnological Society of America)	500	139	27. 8	36	25. 9
Mammalogists, American Society of	450	325	72. 2	143	44. 0
Mycology (Mycological Society of America)	450	150	33. 3	21	14. 0
Nutrition, American Institute of	330	155	47. 0	14	9. 0
Parasitologists, American Society of	525	250	47. 6	78	31. 2
Physiology (American Physiological Society)	1, 000	475	47. 5	60	12. 6
Physiologists, Plant, American Society of	1, 000	299	29. 9	34	11. 3
Phytopathology (The American Phytopathological Society)	1, 350	553	41. 0	101	18. 3
Poultry Science (Poultry Science Assn.)	500	259	51. 8	65	25. 1
Zoologists, American Society of	1, 200	610	50. 8	86	14. 1
CHEMISTRY (American Chemical Society)	48, 000	30, 417	63. 4	4, 506	14. 8
ENGINEERING:					
Civil (American Society of Civil Engineers)	18, 000	7, 610	42. 3	3, 242	42. 7
Mechanical (The Amer. Soc. of Mech. Engrs.)	18, 000	5, 802	32. 2	2 041	35. 2

Table III. Questionnaire Coverage and Returns from Eight Major Scientific Fields and Their Respective Disciplines—Continued

Scientific Fields and Disciplines	Number of Questionnaires Sent	Number of Questionnaires Returned	Percent Return	Number with Military Service	Percent of Those Making Returns Who had Military Service
GEOGRAPHY (American Soc. for Prof. Geographers)	1, 800	550	30. 6	111	20. 2
GEOLOGY:					
(The Geological Society of America)	1, 800	787	43. 5	87	11. 1
(The American Association of Petroleum Geologists)	5, 300	2, 355	44. 5	518	22. 0
MATHEMATICS (American, Mathematical Society and Institute of Mathematical Statistics)	4, 000	1, 428	35. 7	317	22. 2
PHYSICS (American Institute of Physics)	8, 440	6, 330	75. 0	623	9. 8
PSYCHOLOGY (American Psychological Assn.)	5, 000	4, 000	80. 0	1, 170	29. 3
Total	134, 598	69, 350	51. 5	15, 157	21. 9

Present Work of Respondents in Nine Scientific Fields

Introduction. The categories employed in table IV are purposely over-simplified. The term "Academic" includes all persons reporting employment by academic institutions, but not all of them are necessarily teachers. The term "Government" includes all public employment, whether Federal, State, county, or municipal. "Industry" is utilized primarily for all those *not* included in other categories. The terms "Student" and "Military Service" are self-explanatory. The nature of the picture is clear. When compared with table V, which outlines the principal wartime occupations of the respondents, the major aspects of the shift of postwar scientific employment are obvious.

In the interests of questionnaire brevity, no attempt was made to secure information concerning prewar occupational distribution. In some fields, there has been a noteworthy shift as between prewar and postwar work. The shift of employment among younger scientists has been discussed by M. H. Trytten [7] who points out that more than one-fourth of the group studied had changed position in the 12 months preceding his analysis, and that a shift of about 45 percent of the respondents would be made during an 18-month period beginning 1 year before his study and ending 6 months after its completion.

[7] Shifts of Employment Among Younger Scientists, by M. H. Trytten, Director, Office of Scientific Personnel, National Research Council; Science, vol. 106, No. 2740, 4 July 1947.

Table IV. Present Work Status of Scientists in Nine Major Scientific Fields

Present Work Status	Scientific Field									
	Biology		Chemistry		Civil Engineering		Mechanical Engineering		Geography	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Academic	4, 487	42. 2	3, 956	13. 0	472	6. 4	389	6. 9	404	75. 1
Industry	2, 121	19. 9	21, 323	70. 1	2, 777	37. 5	4, 387	77. 7	11	2. 0
Government	3, 261	30. 7	2, 326	7. 7	3, 607	48. 7	519	9. 2	80	14. 9
Military Service	98	. 9	151	. 5	161	2. 2	124	2. 2	7	1. 3
Student	553	5. 2	2, 235	7. 3	78	1. 0	68	1. 2	21	3. 9
Retired, Unemployed, and Other	119	1. 1	414	1. 4	311	4. 2	160	2. 8	15	2. 8
Total	10, 639	100. 0	30, 405	100. 0	7, 406	100. 0	5, 647	100. 0	538	100. 0
Percent of Grand Total		15. 9		45. 5		11. 1		8. 5		. 8

Present Work Status	Scientific Field—Continued								Total all fields	
	Geology		Mathematics		Physics		Psychology			
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Academic	486	16. 5	936	67. 8	2, 405	38. 5	717	46. 0	14, 252	21. 3
Industry	1, 981	67. 2	149	10. 8	2, 542	40. 7	*168	10. 8	35, 459	53. 1
Government	341	11. 5	133	9. 6	750	12. 0	**482	30. 9	11, 499	17. 2
Military Service	14	. 5	9	. 7	38	. 6	7	. 4	609	. 9
Student	47	1. 6	120	8. 7	431	6. 9	162	10. 4	3, 715	5. 6
Retired, Unemployed, and Other	80	2. 7	33	2. 4	81	1. 3	24	1. 5	1, 237	1. 9
Total	2, 949	100. 0	1, 380	100. 0	6, 247	100. 0	1, 560	100. 0	66, 771	100. 0
Percent of Grand Total		4. 4		2. 1		9. 4		2. 3		100. 0

*This figure includes 48 psychologists engaged in private practice or operating private clinical or guidance centers.

**This figure includes 287 clinical psychologists employed in municipal, State, or Federal clinical and guidance centers, or hospitals; and 46 school psychologists.

General Kinds of Work by Scientific Field. In general, biologists are employed principally in academic and Government work (72.9 percent); chemists in academic and industrial positions (83.1 percent); civil engineers by industrial and public agencies (86.2 percent); mechanical engineers in industry (77.7 percent); geographers by academic and governmental agencies (90 percent); geologists in industrial, academic, and governmental positions, the latter almost entirely in the United States Geological Survey and Bureau of Mines (95.2 percent). Mathematicians, 88.2 percent; physicists, 91.2 percent; and psychologists, 87.7 percent are also employed in industrial, academic, or governmental positions.

One may, therefore, make the generalization that biology, geography, mathematics, physics [8] and psychology are "academic" fields, since the largest single percentage of each is in this category. The other fields are "industrial" in emphasis.

Serious Losses from the Armed Services. The most startling fact revealed by table IV is the small number of professional scientists who reported postwar membership in the armed services. Only three fields—chemistry, civil engineering, and mechanical engineering—indicate appreciable numbers remaining in uniform. It is true, of course, that the Armed Services are enrolling considerable numbers of officers in civilian graduate schools, most of them for work to the M. S. level. Many former officers are also employed as civilians in laboratories operated by the Services. Despite this fact, it is disturbing that so few professional scientists find a permanent military career attractive at a time when the research and development budget of the Services is at an all-time high for a period of peace.

Principal War Work of Scientists and Engineers

Introduction. Table V summarizes the principal war work of respondents in seven fields of basic science. The civil and mechanical engineering questionnaires required a different kind of analysis and are summarized in table VI.

It is to be noted that the data in tables V and VI do not agree exactly with, for example, those in table XIII which show military service. Military service at any time during the war is shown in the latter table, whereas tables V and VI contain data pertinent only to those respondents for whom military service was their *principal* occupation between 1942 and 1945. Differences between the questionnaires used by the various societies also preclude exact comparison of some of the data.

[8] The Survey by the Institute of Physics included all subscribers to their journals, with an estimated 12 percent who were not professional physicists.

Table V. Principal War Work of Scientists in Seven Major Scientific Fields

Principal War Work	Total		Scientific Field					
			Biology		Chemistry		Geography	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Academic	6, 614	12. 9	1, 382	17. 6	2, 571	8. 5	303	56. 3
Industry	21, 818	42. 7	934	11. 9	17, 677	58. 1	10	1. 9
Government	12, 432	24. 3	2, 742	35. 0	5, 435	17. 9	112	20. 8
Student	2, 357	4. 6	404	5. 2	1, 654	5. 4	11	2. 0
Military Service	7, 913	15. 5	2, 372	30. 3	3, 080	10. 1	101	18. 8
Retired, Unemployed and Other	25	0. 0	No data		No data		1	0. 2
Total	51, 159	100. 0	7, 834	100. 0	30, 417	100. 0	538	100. 0
Percent Each Column Total is of Grand Total	----------	100. 0	----------	15. 3	----------	59. 5	----------	1. 0

Table V. Principal War Work of Scientists in Seven Major Scientific Fields—Continued

Principal War Work	Scientific Field							
	Geology		Mathematics		Physics		Psychology	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Academic	326	10. 8	664	48. 5	1, 368	21. 7	No data	
Industry	1, 563	52. 2	94	6. 9	1, 540	24. 4	No data	
Government	492	16. 3	306	22. 3	2, 827	44. 8	*518	30. 7
Student	43	1. 4	61	4. 5	184	2. 9	No data	
Military Service	555	18. 5	244	17. 8	391	6. 2	*1, 170	69. 3
Retired, Unemployed, and Other	24	0. 8	No data		No data		No data	
Total	3, 003	100. 0	1, 369	100. 0	6, 310	100. 0	*1, 688	100. 0
Percent each Column Total is of Grand Total	----------	5. 9	----------	2. 7	----------	12. 3	----------	3. 3

*These figures represent psychologists who were engaged in the kind of work shown at some time during the war. They do not necessarily represent *principal* war work. Because some psychologists were in both civilian employment with the Government as well as in military service, the total of 1,688 contains 127 duplication of persons.

Table VI. Principal War Work of Civil and Mechanical Engineers

	Principal War Work	Total		Engineering Field			
				Civil		Mechanical	
		Number	Percent	Number	Percent	Number	Percent
01	Adm. Mgt. Non-Technical	363	2. 8	231	3. 2	132	2. 4
02	Adm. Mgt. Technical	3, 352	26. 6	2, 039	28. 3	1, 313	24. 1
03	Analysis and Testing	297	2. 3	117	1. 6	180	3. 3
04	Construction Supervision	1, 186	9. 4	1, 042	14. 5	144	2. 6
05	Consulting, Independent	296	2. 3	232	3. 2	64	1. 2
06	Consult. as employee of Private Firm	400	3. 2	212	2. 9	188	3. 5
07	Design	1, 812	14. 4	1, 065	14. 8	747	13. 7
08	Development	581	4. 6	127	1. 8	454	8. 3
09	Drafting	155	1. 2	106	1. 5	49	. 9
10	Edit. and Writing	85	. 7	47	. 7	38	. 7
11	Estimating	83	. 7	52	. 7	31	. 6
12	Inspection	196	1. 6	117	1. 6	79	1. 5
13	Installation	66	. 5	10	. 1	56	1. 0
14	Library and Information Serv.	6	0	4	. 1	2	. 1
15	Maintenance	327	2. 6	112	1. 6	215	4. 0
16	Operation	296	2. 3	108	1. 5	188	3. 5
17	Patents	13	. 1	2	0	11	. 2
18	Pers.-Labor Problems	34	. 3	21	. 3	13	. 2
19	Production	283	2. 2	77	1. 1	206	3. 8
20	Research in Basic Science	41	. 3	22	. 3	19	. 3
21	Research, Applied	438	3. 4	178	2. 5	260	4. 8
22	Retired	24	. 2	18	. 2	6	. 1
23	Safety Engineering	29	. 2	17	. 2	12	. 2
24	Sales	113	. 9	33	. 5	80	1. 5
25	Student	729	5. 8	342	4. 8	387	7. 1
26	Teaching, Coll. or University	485	3. 8	254	3. 5	231	4. 2
27	Teaching, Other	53	. 4	27	. 4	26	. 5
28	Unemployed	17	. 1	12	. 2	5	. 1
29	Any Occup. Status not spec	873	6. 9	570	7. 9	303	5. 6
	Total	12, 633	100. 0	7, 194	100. 0	5, 439	100. 0
	Percent Each Column Total is of Grand Total	-------	100. 0	------	56. 9	------	43. 1

When table V is compared with table IV the major shifts of employment as between the period 1942–45 and subsequently are quite apparent. In general, it is believed that the postwar trends are roughly the reverse of the shifts of scientific manpower at the beginning of the war.

Significant Shifts in Employment. Academic institutions now employ 25.0 percent of the scientists in the seven basic science fields. During the war only 12.9 percent were so employed. Government,

by contrast, gained approximately 7 percent during the war; industry lost more than 10 percent. The relative percentage of "students" during the war period as compared with the postwar period is about what is to be expected in the light of the strong "back-to-school" movement and the encouragement of veterans through the GI bill. On the other hand, the contrast between 15.5 percent reporting principal war work as military service and the less than 1 percent reporting military service in 1947 suggests a mass migration of scientists back to normal civilian employment as soon after VJ-day as they could be released by the services.

Educational Level of Respondents in Nine Scientific Fields

The educational level of most of the respondents to the survey is summarized in table VII. Only 66,481 answered the particular question which dealt with formal education in the field of specialization.

Complicating Factors. Two major factors complicate some of the data in table VII. In the first place the Institute of Physics circularized all subscribers to their technical journals, which meant that approximately 1,000 individuals who were not professional physicists were included among those to whom the approximately 8,000 questionnaires were sent. The second factor relates to the wide differences between the types of employment of scientists in the nine major scientific fields.

Differences in Training by Fields. Those scientific fields whose members are employed mainly by industry do not accentuate the possession of formal advanced degrees. On the other hand, an advanced degree is a necessity for employment and adequate advancement in those subjects which have been in the past primarily academic in emphasis. Thus chemistry, civil engineering, mechanical engineering, and geology are primarily industrial in character with the great majority of men trained in these fields employed in industry as indicated in tables VIII and IX. Biology, geography, mathematics, physics, and psychology have been utilized primarily by academic institutions although this practice has changed somewhat during and since the last war.

As would be expected, since approximately two-thirds of the respondents are chemists or engineers, the largest single category of respondents hold the bachelor's degree only. Nevertheless more than one-fourth of the respondents in all nine fields combined have received the doctorate and an additional one-fifth possess an M. S. or M. A. degree. Fewer than 10 percent have not completed the baccalaureate.

Respondents with Ph. D. In considering the individual fields, the high percentages of Ph. D. degrees fall in those fields which have academic emphasis. More than half of the respondents in the fields of mathematics and psychology have received the doctorate, two-

Table VII. Education Level of Scientists in Nine Major Occupational Fields

Academic Level	Scientific Field									
	Biology		Chemistry		Civil Engineering		Mechanical Engineering		Geography	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Ph. D	4, 429	43. 3	8, 793	28. 9	176	2. 4	192	3. 4	165	30. 7
Master	2, 511	24. 5	5, 924	19. 5	1, 409	19. 0	971	17. 2	201	37. 3
Bachelor	2, 672	26. 0	13, 745	45. 2	5, 066	68. 4	3, 913	69. 3	112	20. 8
Incomplete College	364	3. 6	1, 955	6. 4	617	8. 3	449	7. 9	45	8. 4
No College Training	270	2. 6	0	0	138	1. 9	122	2. 2	15	2. 8
Total	10, 246	100. 0	30, 417	100. 0	7, 406	100. 0	5, 647	100. 0	538	100. 0
Percent of Grand Total	--------	15. 4	--------	45. 8	--------	11. 1	--------	8. 5	--------	. 8

Academic Level	Scientific Field—Continued								Total All Fields	
	Geology		Mathematics		Physics		Psychology		Number	Percent of Grand Total
	Number	Percent	Number	Percent	Number	Percent	Number	Percent		
Ph. D	828	27. 6	739	53. 5	2, 280	36. 3	844	54. 0	18, 446	27. 7
Master	680	22. 6	361	26. 2	1, 238	19. 7	630	40. 5	13, 925	20. 9
Bachelor	1, 329	44. 3	167	12. 1	1, 217	19. 4	86	5. 5	28, 307	42. 7
Incomplete College	129	4. 3	113	8. 2	814	12. 9	0	0	4, 486	6. 7
No College Training	37	1. 2	0	0	735	11. 7	0	0	1, 317	2. 0
Total	3, 003	100. 0	1, 380	100. 0	6, 284	100. 0	1, 560	100. 0	66, 481	100. 0
Percent of Grand Total	--------	4. 5	--------	2. 1	--------	9. 5	--------	2. 3	--------	100. 0

Table VIII. Present Work Status of Scientists in Seven Major Scientific Fields, Distributed on the Basis of Educational Level

Present Work Status	Total		Educational Level									
	Number	Percent of Grand Total	Doctorate		Master		Bachelor		Incomplete College		No College Training	
			Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Academic	13, 093	24. 6	8, 507	47. 1	2, 518	21. 9	1, 250	6. 5	511	15. 0	307	29. 1
Industry	28, 252	53. 0	6, 976	38. 5	5, 335	46. 3	13, 228	68. 5	2, 156	63. 1	557	52. 8
Government	7, 233	13. 5	2, 235	12. 4	1, 998	17. 3	2, 541	13. 2	342	10. 0	117	11. 1
Military Service	336	. 6	57	. 3	82	. 7	166	. 9	15	. 4	16	1. 5
Student	3, 650	6. 8	70	. 4	1, 419	12. 3	1, 797	9. 3	323	9. 6	41	3. 9
Retired, Unemployed, and Other	797	1. 5	228	1. 3	172	1. 5	314	1. 6	66	1. 9	17	1. 6
Total	53, 361	100. 0	18, 073	100. 0	11, 524	100. 0	19, 296	100. 0	3, 413	100. 0	1, 055	100. 0
Percent Each Column Total is of Grand Total	-------	100. 0	-------	33. 9	-------	21. 5	-------	36. 2	-------	6. 4	-------	2. 0

Table IX. Present Work Status of Civil and Mechanical Engineers, Distributed on the Basis of Educational Level

	Present Work Status	Total		Educational Level									
				Doctorate		Master		Bachelor		Incomplete College		No College Training	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
01	Admin. Mgmt. Non-Technical	339	2. 6	11	3. 0	59	2. 5	206	2. 3	51	4. 8	12	4. 6
02	Admin. Mgmt. Technical	3, 509	27. 2	81	22. 1	626	26. 6	2, 325	26. 2	388	36. 3	89	34. 1
03	Analysis and Testing	246	1. 9	1	. 3	39	1. 7	194	2. 2	10	. 9	2	. 8
04	Construction Supervision	971	7. 5	7	1. 9	95	4. 0	730	8. 3	113	10. 6	26	10. 0
05	Consulting, Independent	813	6. 3	43	11. 7	176	7. 5	475	5. 4	99	9. 3	20	7. 7
06	Consult. as employee of Private Firm	700	5. 4	9	2. 4	125	5. 3	493	5. 6	60	5. 6	13	5. 0
07	Design	2, 085	16. 2	13	3. 5	296	12. 6	1, 615	18. 3	133	12. 5	28	10. 8
08	Development	602	4. 7	11	3. 0	75	3. 2	476	5. 4	30	2. 8	10	3. 8
09	Drafting	183	1. 4	0	0	17	. 7	156	1. 8	8	. 8	2	. 8
10	Editing and Writing	99	. 8	3	. 8	15	. 6	71	. 8	8	. 8	2	. 8
11	Estimating	185	1. 4	1	. 3	14	. 6	156	1. 8	10	. 9	4	1. 5
12	Inspection	139	1. 1	0	0	11	. 5	115	1. 3	9	. 8	4	1. 5
13	Installation	52	. 4	0	0	0	0	45	. 5	5	. 5	2	. 8
14	Library and Information Service	4	0	0	0	1	0	3	0	0	0	0	0
15	Maintenance	212	1. 6	0	0	12	. 5	178	2. 0	16	1. 5	6	2. 3
16	Operation	162	1. 3	0	0	19	. 8	127	1. 4	12	1. 1	4	1. 5
17	Patents	22	. 2	0	0	5	. 2	13	. 1	3	. 3	1	. 4
18	Personnel-Labor Problems	20	. 2	0	0	2	. 1	15	. 2	2	. 2	1	. 4
19	Production	224	1. 7	1	. 3	20	. 8	195	2. 2	5	. 5	3	1. 2
20	Research in Basic Science	76	. 6	8	2. 2	27	1. 1	40	. 5	1	. 1	0	0
21	Research, Applied	471	3. 7	41	11. 1	149	6. 3	264	3. 0	14	1. 3	3	1. 2
22	Retired	127	1. 0	6	1. 6	30	1. 3	62	. 7	16	1. 5	13	5. 0
23	Safety Engineering	33	. 3	0	0	5	. 2	25	. 3	1	. 1	2	. 8

24	Sales	428	3.3	2	.5	27	1.1	349	3.9	43	4.0	7	2.7
25	Student	146	1.1	2	.5	46	2.0	93	1.1	5	.5	0	0
26	Teaching, College or University	825	6.4	115	31.3	430	18.2	276	3.1	4	.4	0	0
27	Teaching, Other	36	.3	3	.8	11	.5	21	.2	1	.1	0	0
28	Unemployed	62	.5	2	.5	10	.4	43	.5	5	.5	2	.8
29	Any Occupational Status not specified	120	.9	8	2.2	16	.7	78	.9	14	1.3	4	1.5
	Total	12,891	100.0	368	100.0	2,358	100.0	8,839	100.0	1,066	100.0	260	100.0
	Percent Each Column Total is of Grand Total	-------	100.0	------	2.9	------	18.3	------	68.5	------	8.3	------	2.0

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fifths of those in biology, and approximately one-third of those in geography and physics. By contrast, fewer than 5 percent of the engineers have reached the doctorate level.

Respondents with Master's. Less significant is the distribution of Master's degrees, since an M. A. or M. S. usually indicates merely a year of additional study beyond the baccalaureate degree. Many respondents included in the B. S., category have probably had graduate work equivalent in amount to the M. S. but for some reason did not obtain a formal advanced degree.

Respondents with Bachelor's Degree. It is noteworthy that in the engineering fields almost 70 percent of the respondents possess only the Bachelor's degree. By contrast only about 5 percent of professional psychologists and 12 percent of the mathematicians have halted their education at this level.

Present Work of Scientists Distributed on the Basis of Educational Level

Table VIII emphasizes the fact that there is a concentration of higher formal degrees in the academic fields. Thus the largest single category of those holding the doctorate (47.1 percent) is employed in academic work. Thirty-eight percent of those holding the Ph. D. are employed in industry and 12 percent in Government. If these figures are compared with the total numbers employed in these categories as indicated in the left-hand column, it will be seen that approximately two-thirds of the scientists (8,507 out of 13,093) who reported academic employment hold a doctorate degree; that approximately one-fourth of those reporting industrial employment hold the doctorate; and nearly one-third of those reporting governmental employment hold the Ph. D. Thus, as compared with total employment, the Government employs its average share of Ph. D's. Industry is well below the average, while a disproportionately large percentage are employed in academic institutions. In all academic levels except the doctorate, however, industry is the principal employer.

The distribution of Ph. D.'s may be accounted for by the highly specialized nature of the teaching carried on in academic institutions, and again by the fact that appropriate advancement of science teachers is usually dependent on holding the advanced degree.

Another factor revealed by this table and discussed in more detail elsewhere, is the small number of scientists who reported that they were still members of the military services. So far as education is concerned, scientists in uniform are distributed as might be expected, with approximately three times as many who hold bachelor's degrees as those who possess the doctorate.

Present Work Status of Civil and Mechanical Engineers on Basis of Educational Level

The nature of the questionnaire used by the civil and mechanical engineers precludes exact comparison of data with the other scientific fields so far as work status is concerned. It is worthy of note, however, that among the 29 occupational or functional categories mentioned on the engineering questionnaire, college and university teaching employs only 6.4 percent of the 12,891 respondents.

Ph. D. Respondents. Of the 368 engineers who reported that they hold the doctorate degree, approximately one-third are employed in teaching. Again a disproportionate share of the high degrees are concentrated in academic work. The second largest category among those who hold the doctorate is in technical administration. Other large groups of Ph. D.'s are engaged in independent consultation and research. The over-all total of these four categories include 76 percent of all doctorate engineers who reported.

Respondents with M. A. or M. S. Among those holding the master's degree the pattern is a little less clear, but 18 percent of the 2,358 who reported are teachers in colleges or universities; 26 percent are engaged in technical administration; 12½ percent in design; 7½ percent in independent consulting; and 6.3 percent in research. Thus, a total of 70.3 percent of engineers holding the master's degree are engaged in five of the 29 occupational categories.

Respondents with Baccalaureate Degrees. Among engineers holding the bachelor's degree much the same distribution may be seen except that the individual percentages are much smaller and the relative number engaged in teaching has dropped very markedly.

Principal War Work of Scientists in Seven Major Fields on the Basis of Education

Table X shows the principal war work of scientists in seven major scientific fields, distributed on the basis of educational level.

Respondents with Doctorate. Of the respondents who held the Ph. D. degree 30.7 percent were engaged in academic work during the war; 28.2 percent were employed by Federal, State, municipal, or local governmental units; and 29.2 percent were employed in industry. The remaining 11.9 percent were in the military service, were students, or were retired or unemployed.

Respondents with Master's Degree. Industry was the most frequent employer of scientists with a master's degree. This was followed in turn by Government, military service, and academic employment in the order listed.

Respondents with Bachelor's Degree. More than half of the respondents with the A. B. degree or its equivalent were in industrial employment during the war with slightly fewer than one-fifth of the total

Table X. Principal War Work of Scientists in Seven Major Scientific Fields, Distributed on the Basis of Their Educational Level

Principal War Work	Total		Educational Level									
			Doctorate		Master		Bachelor		Incomplete College		No College Training	
	Number	Percent of Grand Total	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Academic	8, 614	16. 3	5, 575	30. 7	1, 688	14. 8	637	3. 5	502	13. 9	212	18. 4
Government	12, 440	23. 6	5, 109	28. 2	2, 855	24. 9	3, 316	18. 0	753	20. 9	407	35. 2
Industry	21, 618	41. 0	5, 302	29. 2	4, 234	36. 9	9, 877	53. 7	1, 784	49. 4	421	36. 4
Military Service	7, 735	14. 7	1, 717	9. 5	2, 071	18. 1	3, 469	18. 8	385	10. 7	93	8. 1
Student	2, 345	4. 4	426	2. 3	611	5. 3	1, 101	6. 0	185	5. 1	22	1. 9
Retired, Unemployed, and Other	22	0	14	. 1	3	0	3	0	2	0	0	0
Total	52, 774	100. 0	18, 143	100. 0	11, 462	100. 0	18, 403	100. 0	3, 611	100. 0	1, 155	100. 0
Percent Each Column Total Is of Grand Total	-------	100. 0	-------	34. 4	-------	21. 7	-------	34. 9	-------	6. 8	-------	2. 2

group in each of the employment categories of Government and military service. Only 3.5 percent of the bachelors were employed in academic positions, which is in sharp contrast with the 14.8 percent of the masters and the 30.7 percent of the doctors who pursued academic work during the war.

Respondents with Incomplete or No College Training. During the war, industry was the chief employer of those respondents who had less than a baccalaureate degree. Government followed as the second ranking employer. A still smaller percentage, yet at the same time a surprisingly large one, was employed in academic work. No explanation is apparent as to why academic institutions employed a higher percentage of nongraduates than of respondents who held only the baccalaureate degree.

Conclusions. If the basic assumption is made that scientists returned after the war to the same general pursuits which they normally followed before the emergency, the major conclusions to be drawn from table X, when considered along with the data of table VIII, are as follows:

1. Approximately one-third of the scientists employed in prewar academic life shifted to some other form of employment during the war.
2. Between one-third and one-fourth of those with higher degrees and approximately one-fifth of those holding the bachelor degree, shifted from prewar industrial work to some other form of endeavor during the war.
3. The principal recipients of the individuals mentioned in 1 and 2 above were Government and the military service.

These conclusions are substantiated by the fact that 13,093 scientists (table VII) in the seven major scientific fields reported present employment as "Academic," while only 8,614 (table X) worked primarily in an academic environment during the war. When considered from the standpoint of their highest reported academic degree, approximately one-third of the doctors and masters and one-half of the bachelors left prewar academic work for other pursuits during the war.

Government employment, which includes all public employment by Federal, State, county, or municipal jurisdictions, almost doubled during the war. This is attested by the fact that 12,440 reported "Government" as their principal employer during the war years (table X) whereas only 7,233 reported Government employment subsequent to the war. The governmental employment of Ph. D's also more than doubled during the war. For those with masters and bachelors degrees the increase was about one-third over prewar figures.

Industrial employment now accounts for 53 percent of the respondents as compared with 41 percent during the war. Among those holding the doctorate, wartime industrial employment was less than half

what it is today. Among those holding the masters and the bachelors degrees a similar difference, though not as great, is apparent.

In general the same conclusion may be drawn from table X as from tables V and VII—that scientists migrated during the war from industry and academic life into Government and the Armed Services, regardless of education, although in different proportions for each educational level.

Principal War Work of Engineers Distributed on the Basis of their Educational Level

Introduction. Table XI shows the principal kinds of work engaged in by civil and mechanical engineers during the war period, distributed on the basis of five levels of educational advancement of the respondents. During the war more than half of the engineer respondents were engaged in the performance of four kinds of activities, which were—(a) administrative management, technical, 26.5 percent; (b) design, 14.4 percent; (c) construction supervision, 9.4 percent; (d) teaching, 4.2 percent.

Respondents with Doctorate. As previously pointed out in a discussion of table IX, 76 percent of the Ph. D. engineers were engaged in college or university teaching, technical administrative management, independent consultation, and independent research.

Respondents with Master's Degrees. Civil and mechanical engineers with a master's degree predominantly were found to be performing the same types of activity as were the Ph. D. respondents, with the exception that designing was a relatively more frequent activity. As compared with the doctorate group, the masters also showed a marked decline in the percentage engaged in applied research.

Respondents with Baccalaureate Degrees. Civil and mechanical engineers with only a baccalaureate degree were concentrated into three types of activity—technical administrative management, construction supervision, and design. These three functional categories account for more than 57 percent of all civil and mechanical engineers who hold only the baccalaureate degree.

Respondents with Incomplete College. Of those with incomplete college, more than 40 percent are engaged in the same three types of activity as were mentioned above for the bachelors.

It is significant that 13.9 percent of civil and mechanical engineers with incomplete college listed "Student" as their principal war work, whereas only one-half of 1 percent listed their present status as "Student." In like manner, 46.9 percent of civil and mechanical engineers who had no college training prior to the war listed "Student" as principal war work.

Serious Teacher Losses. Insofar as present work status accurately reflects prewar work status, certain significant wartime losses are to be noted. College and university engineering teachers with the

Table XI. Principal War Work of Civil and Mechanical Engineers, Distributed on the Basis of their Educational Level

	Principal War Work	Total		Educational Level									
		Number	Percent of Grand Total	Doctorate		Master		Bachelor		Incomplete College		No College Training	
				Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
01	Adm. Mgmt. Non-Technical	363	2. 9	8	2. 7	57	3. 1	225	3. 2	56	1. 9	17	2. 7
02	Adm. Mgmt. Technical	3, 352	26. 5	65	22. 1	539	29. 2	2, 131	30. 6	524	17. 7	93	14. 7
03	Analysis and Testing	297	2. 3	5	1. 7	39	2. 1	132	1. 9	113	3. 8	8	1. 3
04	Construction Supervision	1, 186	9. 4	10	3. 4	115	6. 3	725	10. 5	297	10. 0	39	6. 2
05	Consulting, Independent	296	2. 3	23	7. 8	62	3. 4	162	2. 3	36	1. 2	13	2. 1
06	Consult. as employee of Private Firm	400	3. 2	11	3. 7	71	3. 9	253	3. 6	58	2. 0	7	1. 1
07	Design	1, 812	14. 4	19	6. 5	229	12. 4	1, 121	16. 1	401	13. 5	42	6. 7
08	Development	581	4. 6	17	5. 8	75	4. 1	325	4. 7	152.	5. 1	12	1. 9
09	Drafting	155	1. 2	0	0	10	. 5	53	. 8	87	2. 9	5	. 8
10	Editing and Writing	123	1. 0	8	2. 7	27	1. 5	46	. 7	2	. 1	40	6. 3
11	Estimating	83	. 7	0	0	. 10	. 5	52	. 8	18	. 6	3	. 5
12	Inspection	196	1. 5	0	0	18	1. 0	125	1. 8	45	1. 5	8	1. 3
13	Installation	66	. 5	0	0	5	. 3	48	. 7	13	. 4	0	0
14	Library and Information Service	6	0	0	0	1	. 1	5	. 1	0	0	0	0
15	Maintenance	327	2. 6	0	0	16	. 9	191	2. 8	113	3. 8	7	1. 1
16	Operation	296	2. 3	2	. 7	29	1. 6	169	2. 4	94	3. 2	2	. 3
17	Patents	13	. 1	0	0	1	. 1	8	. 1	3	. 1	1	. 2
18	Personnel-Labor Problems	34	. 3	2	. 7	14	. 8	11	. 2	6	. 2	1	. 2
19	Production	283	2. 2	0	0	24	1. 3	166	2. 4	88	3. 0	5	. 8
20	Research in Basic Science	41	. 3	7	2. 4	5	. 3	20	. 3	9	. 3	0	0
21	Research, Applied	438	3. 5	59	20. 1	111	6. 0	177	2. 6	87	2. 9	4	. 6
22	Retired	24	. 2	2	. 7	5	. 2	12	. 2	3	. 1	2	. 3
23	Safety Engineering	29	. 2	1	. 3	4	. 2	19	. 3	4	. 1	1	. 2

Table XI. Principal War Work of Civil and Mechanical Engineers, Distributed on the Basis of their Educational Level—Continued

	Principal War Work	Total		Educational Level									
		Number	Percent of Grand Total	Doctorate		Master		Bachelor		Incomplete College		No College Training	
				Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
24	Sales	113	0. 9	2	0. 7	11	0. 6	78	1. 1	19	0. 6	3	0. 5
25	Student	729	5. 7	0	0	0	0	20	. 3	413	13. 9	296	46. 9
26	Teaching, College or University	485	3. 8	45	15. 3	253	13. 7	154	2. 2	31	1. 0	2	. 3
27	Teaching, Other	53	. 4	2	. 7	12	. 7	29	. 4	10	. 3	0	0
28	Unemployed	17	. 1	0	0	1	. 1	2	0	5	. 2	9	1. 4
29	Any Occupational Status not specified	873	6. 9	6	2. 0	94	5. 1	477	6. 9	286	9. 6	10	1. 6
	Total	12, 671	100. 0	294	100. 0	1, 838	100. 0	6, 936	100. 0	2, 973	100. 0	630	100. 0
	Percent Each Column Total is of Grand Total	-------	100. 0	------	2. 3	------	14. 5	------	54. 7	------	23. 5	------	5. 0

Ph. D. degree dropped from 115 before the war to 45 during the war. Teachers with masters degrees dropped from 430 to 253. This was a serious loss in terms of maintaining the potential supply of college-trained engineers who would be needed in the immediate postwar period.

Present Work of Scientists Compared with Kinds of Work During the War

Table XII summarizes the previous remarks concerning the shift of employment between the war period of 1942 to 1945 and the postwar period. This table reveals the detailed shifts in employment from principal war work to principal postwar employment in the seven basic science fields.

Present Work—Academic. Referring to table XII under the column headed "Academic," it is noted that 25.1 percent of the scientists now employed in academic life had been in military service during the major portion of the period 1942 to 1945, while 49 percent of those now in academic life had been in the same kind of work at some time during the war. One can conclude, on the assumption that prewar and postwar work of scientists follow the same general pattern, that approximately 50 percent of the scientists in academic work before the war migrated to industry, Government, and military service during the war.

Present Work—Industrial. By contrast, 71.6 percent of the respondents who reported postwar industrial employment had been so employed during the war.

Present Work—Governmental. Of those who reported governmental employment as their present work, 71 percent had been employed by the Government during the war; 21.2 percent had been in the military service; and minor numbers had been employed in industry and academic life or were students.

Present Work—Student. Of those who reported that they were students at the time they filled out the questionnaires, only slightly more than one-fifth had been students during the war; more than one-third had been in military service and had returned to complete their studies; almost one-fourth had been employed by Government agencies; 13 percent by industry; and less than 5 percent by academic institutions.

Over-all Conclusions. The significant trends of employment between the war period and postwar indicate a migration back to the universities and to industry from Government and military service. It also shows that a considerable number of respondents returned to graduate school to complete their education. Significant in this connection is the fact that so few scientists report military service as their present work. Of the 9,887 who reported military service throughout the period 1942 to 1945, only 329 report military service as their present type of employment. This is a very low figure and

*Table XII. Present Work Status of Scientists in Seven Major Scientific Fields, Distributed on the Basis of Kinds of Work Done During the War**

Principal War Work	Present Work Status							
	Academic		Industry		Government		Military Service	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Academic	7, 400	49. 0	409	1. 5	181	2. 5	10	3. 0
Industry	664	4. 4	19, 901	71. 6	259	3. 6	71	21. 6
Government	2, 907	19. 2	3, 825	13. 8	5, 187	71. 2	61	18. 6
Military Service	3, 806	25. 1	3, 053	11. 0	1, 532	21. 2	176	53. 5
Student	351	2. 3	590	2. 1	107	1. 5	11	3. 3
Retired, Unemployed, and Other	4	0	2	0	0	0	0	0
Total	15, 132	100. 0	27, 780	100. 0	7, 266	100. 0	329	100. 0

Principal War Work	Present Work Status				Total	
	Student		Retired, Unemployed, Other			
	Number	Percent	Number	Percent	Number	Percent of Grand Total
Academic	144	4. 2	107	18. 2	8, 251	15. 2
Industry	461	13. 5	197	33. 6	21, 553	39. 5
Government	810	23. 8	149	25. 3	12, 939	23. 8
Military Service	1, 214	35. 7	106	18. 1	9, 887	18. 1
Student	777	22. 8	28	4. 8	1, 864	3. 4
Retired, Unemployed, and Other	0	0	0	0	6	0
Total	3, 406	100. 0	587	100. 0	54, 500	100. 0

*This table should be read as follows: Of the 15,132 scientists presently engaged in academic work, 7,400 or 49.0 percent were in academic work during the war; 664 or 4.4 percent of those now in academic work were in industry during the war, etc. Likewise, of the 3,406 scientists who reported their present work status as "Student," 144 or 4.2 percent reported "Academic" as their principal war work; 461 or 13.5 percent of present students reported "Industry" as their principal war work, etc. In like fashion, of the grand total of 54,500 scientists presently engaged in the six work categories, 8,251 or 15.2 percent of those presently employed reported "Academic" as their principal war work; 21,553 or 39.5 percent reported their principal war work as "Industry"; 12,939 or 23.8 percent of presently employed scientists showed their principal war work as "Government."

indicates a mass migration by scientists back to other pursuits. In addition, the table reveals that only slightly more than half of those who reported military service in 1947 were in uniform during the period 1942 to 1945.

Method of Entry Into Armed Forces

Table XIII summarizes the method of entry of the 14,825 scientists who experienced military service and who reported on this question. This table and tables XV, XVI, and XVII summarize various aspects of the technical utilization of scientists in uniform during World War II. The general factors which are believed to have governed the nature of this utilization have been discussed in chapter 1.

Methods of Entry—Numbers and Fields. Reference to table XIII reveals that 3,761 (25.4 percent) of the respondents with military service were drafted and 3,155 (21.3 percent) entered the Services by voluntary enlistment. Many felt subsequently that they had made a much larger contribution to the war effort as *civilians* (table XIX).

A total of 3,529 (23.8 percent) held Reserve commissions and were called to duty in large measure in the branches in which they were originally commissioned.

The circumstance (revealed in table XVI) that more than 35 percent of these Reservists were poorly utilized in their respective fields of greatest competence at a time when the Services needed technical competence is indicative of a definite lack of adequate planning.

Table XIII shows that in a number of fields, that is, biology, geography, mathematics, and psychology, the Reserve category was the smallest reported. Returns indicate that only 7 percent of the psychologists who entered the armed forces came in by way of a Reserve commission. This is in startling contrast to the 40.5 percent who received direct commissions.

Various reasons have been offered to explain the small numbers of Reserve officers in these fields. One is that the services did not realize before the war that these sciences could be useful to them. Another reason advanced is that these fields are highly academic and professors were not interested in military affairs. This may have been true prior to 1940; there is good evidence to show that it is not true today. A third explanation advanced by some people is that the members of these scientific fields did not usually attend institutions where ROTC was mandatory. There is probably some truth in all of these statements, and no single explanation. On the other hand, it is also true that chemistry, engineering, and physics had been utilized previously by the services, and in these fields the percentage of Reserve officers was relatively high.

The most frequent method of entrance into uniform was by way of direct commission from civilian life. Of those reporting military

Table XIII. Methods by Which Scientists in Nine Major Scientific Fields Were Inducted into Military Service

Method of Entry into Armed Forces	Scientific Field									
	Biology		Chemistry		Civil Engineering		Mechanical Engineering		Geography	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Draft	802	28. 3	1, 440	35. 6	411	13. 0	342	17. 0	38	34. 2
Reserve	538	19. 0	1, 054	26. 0	975	30. 8	559	28. 0	9	8. 1
Voluntary Enlistment	726	25. 7	695	17. 2	611	19. 3	574	28. 5	25	22. 5
Direct Commission	764	27. 0	857	21. 2	1, 168	36. 9	534	26. 5	39	35. 2
Total	2, 830	100. 0	4, 046	100. 0	3, 165	100. 0	2, 009	100. 0	111	100. 0
Percent of Grand Total		19. 1		27. 3		21. 3		13. 6		. 7

Method of Entry into Armed Forces	Scientific Field								Total All Fields	
	Geology		Mathematics		Physics		Psychology			
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent of Grand Total
Draft	99	16. 9	93	30. 7	145	23. 9	391	33. 4	3, 761	25. 4
Reserve	136	23. 2	42	13. 8	134	22. 1	82	7. 0	3, 529	23. 8
Voluntary Enlistment	150	25. 6	62	20. 5	89	14. 7	223	19. 1	3, 155	21. 3
Direct Commission	201	34. 3	106	35. 0	238	39. 3	473	40. 5	4, 380	29. 5
Total	586	100. 0	303	100. 0	606	100. 0	1, 169	100. 0	14, 825	100. 0
Percent of Grand Total		4. 0		2. 0		4. 1		7. 9		100. 0

service, 4,380 (29.5 percent) received direct commissions. In six of the nine scientific fields, more than one-third of the respondents were included in this category.

Utilization of Scientists and Technologists in Nine Major Fields

Tables XIV through XVII, inclusive, are concerned with the technical utilization of scientists by the armed forces during World War II. Table XIV is a repetition of table II which was presented in chapter 1. It is presented here for the convenience of the reader and as a ready reference to the five utilization categories and their respective definitions.

In the fields of civil and mechanical engineering, and psychology, the utilization categories and their definitions were printed on the questionnaire, and were marked direct by the respondents. In all other fields the utilization category was determined by an analysis of the assignments and the narrative statements of the respondent relative to his utilization.

Table XIV. Utilization Categories and Their Definitions

Category No.	Definition
1	Utilized in primary field and at proper level of competence (training and experience) throughout most of military service.
2	Utilized in primary field and at proper level of competence for at least half of the time in military service.
3	Not utilized in primary field of training and experience but did utilize, throughout military service, the collateral fields in which the scientist had received training or gained experience.
4	Utilized in primary field or in collateral field for only a relatively short period of military service.
5	Utilized in neither primary field nor in any of the collateral fields while in military service.

Factors Influencing Utilization. In general, the technical utilization of scientists in the Services appears to have been directly related to Service familiarity with the science in question and to familiarity of the individual with military applications of his particular technical skill. This was modified by a number of factors including method of induction, initiative of the individual in seeking technical assignments, whether he was enlisted or commissioned, and the pressures which could be applied by interested individuals either within or outside the Service to secure his transfer to a position which would insure better utilization of technical competence.

Thus, although psychology had not been represented to any considerable extent in the Services prior to the war, the need for large numbers of psychologists to test and classify millions of men resulted

Table XV. Comparative Degree of Utilization of Scientists in the Armed Forces, Distributed on the Basis of Nine Major Scientific Fields

Degree of Utilization	Scientific Field									
	Biology		Chemistry		Civil Engineering		Mechanical Engineering		Geography	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	636	22. 5	948	23. 9	1, 079	33. 7	696	34. 4	38	37. 6
2	325	11. 5	500	12. 6	559	17. 4	286	14. 1	30	29. 7
3	323	11. 4	801	20. 2	697	21. 8	524	25. 9	14	13. 9
4	321	11. 3	634	16. 0	461	14. 4	240	11. 8	6	5. 9
5	1, 225	43. 3	1, 084	27. 3	406	12. 7	279	13. 8	13	12. 9
Total	2, 830	100. 0	3, 967	100. 0	3, 202	100. 0	2, 025	100. 0	101	100. 0
Percent of Grand Total		19. 1		26. 9		21. 7		13. 7		. 7

Degree of Utilization	Scientific Field								Total All Fields	
	Geology		Mathematics		Physics		Psychology			
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent of Grand Total
1	30	5. 0	108	35. 5	304	52. 2	532	45. 6	4, 371	29. 6
2	131	21. 6	35	11. 6	97	16. 9	310	26. 5	2, 273	15. 4
3	141	23. 3	33	10. 9	14	2. 4	163	14. 0	2, 710	18. 3
4	84	13. 9	55	18. 2	131	22. 5	102	8. 7	2, 034	13. 7
5	219	36. 2	72	23. 8	35	6. 0	61	5. 2	3, 394	23. 0
Total	605	100. 0	303	100. 0	581	100. 0	1, 168	100. 0	14, 782	100. 0
Percent of Grand Total		4. 1		2. 0		3. 9		7. 9		100. 0

in an unprecedented demand. Furthermore, the American Psychological Association and professional psychologists either in or associated with the Services, secured the reassignment of large numbers of psychologists initially placed in nontechnical assignments. The same situation obtained in the field of physics. The editorial committee of the Institute of Physics which analyzed the results of this survey estimated that 25 percent of the professional physicists in uniform were thus reassigned.

In geography, the numbers nationally were so small that few entered the Service. Their application to military activities was rather obvious, and on the whole, quite satisfactory.

Utilization of Scientists on the Basis of Method of Entry into the Armed Forces

Table XVI summarizes the technical utilization of 14,773 scientists on the basis of their method of entry into uniform. It is noteworthy that the group reporting full and complete utilizations was the most numerous; that is, that almost 30 percent of the scientists were utilized throughout their service in their respective fields of specialization. The relatively satisfactory size of this group is in part occasioned by the high percentage of excellent utilization among directly commissioned personnel.

Table XVI. Utilization of Scientists by the Armed Forces, Distributed on the Basis of Their Method of Entry Into Military Service

Degree of Utilization	Total		Method of Entry							
			Draft		Reserve		Volunt. Enlist.		Dir. Commission	
	Number	Percent*	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	4, 378	29. 6	760	20. 2	1, 116	31. 7	697	22. 4	1, 805	41. 2
2	2, 252	15. 2	554	14. 8	475	13. 5	441	14. 2	782	17. 8
3	2, 708	18. 4	633	16. 9	673	19. 1	598	19. 2	804	18. 3
4	2, 042	13. 9	667	17. 8	484	13. 7	434	13. 9	457	10. 4
5	3, 393	22. 9	1, 133	30. 3	778	22. 0	943	30. 3	539	12. 3
Total	14, 773	100. 0	3, 747	100. 0	3, 526	100. 0	3, 113	100. 0	4, 387	100. 0

*Percent figures are percents of the Method of Entry (column) totals.

It is considered reasonable to designate categories 1, 2, and 3 as including excellent to fairly satisfactory technical utilization, since all indicate some use of the respondents' scientific training and experience. By contrast, categories 4 and 5 are definitely indicative of a waste of scientific talent and knowledge. (See table XIV.) Thus 5,435 (36.8 percent) of the professional scientists were placed in mili-

tary assignments which presumably could have been carried out as satisfactorily by men without technical training or experience.

Utilization of Draftees. Examination of the records of scientists drafted into the Services reveals that slightly over one-half (51.9 percent) used their scientific background to some degree. It must be noted in this connection, however, that the No. 5 utilization category is by far the largest (30.3 percent) for draftees; and that a draftee had only one chance in five of utilizing his scientific competence throughout his military service.

Utilization of Enlistees. The utilization of voluntary enlistees was slightly more effective than that of draftees as evidenced by the fact that 55.8 percent were technically used. Of the enlistees, however, 30.3 percent were unable to use their technical education and experience at any time while in uniform.

Both draftees and enlistees were under considerable handicaps in obtaining good technical utilization. It was rarely that an enlisted man was in a position to apply his full technical competence. The manning tables made little provision for competent scientists who entered the Service at the enlisted level, and the proposed assignments usually were routine "technician" jobs, if heed was paid at all to the enlisted man's civilian background. In addition, the command function properly vested in officers made it very difficult indeed for an enlisted man to make a technical contribution at the professional level.

War Department Technical Detachment. Early in 1944 the induction of large numbers of scientific and technological personnel was accelerated. This loss of scientific personnel became a matter of considerable concern to both civilian and military establishments responsible for research and development of military devices and techniques. The War Department Technical Detachment was established to meet this situation.

The major objective of the Technical Detachment was to insure directed initial assignments for enlisted men who were professionally qualified scientists and engineers, to effect transfers for those misassigned, and to prevent misuse of such men after proper assignment.

The Technical Detachment began operations in September 1944 and was discontinued in March 1946, when the induction of scientists under Selective Service ceased. During this period the qualifications of about 2,500 men were critically examined and directed assignments were made for approximately 2,000 of this group.

The lessons learned from the operation of the Technical Detachment during World War II should provide a partial basis for planning for the mobilization of scientists in the event of another national emergency. For the relatively small group which may be inducted into the Army under the Selective Service Act of 1948, an organization

molded along the lines of the Technical Detachment might well be established to clarify procedures necessary for any future mobilization.

Utilization of Reserve Officers. Scientists who entered Service via the Organized Reserve Corps should have been well utilized. A great many of them had been on the Service rolls for years and their qualifications should have been known to the assignment agencies. Yet more than one-third of these Reserve officers failed to utilize their technical competence while in uniform. The percentage of good technical utilization of Reservists (categories 1, 2, and 3, table XIV) was only the average of all four methods of entry into the Armed Services.

Apparently little care had been taken between World War I and II to evaluate the possible utilization of these officers. Among those who had received a Reserve commission upon graduation from college, the tendency was to maintain their assignment in the basic branch represented by the Reserve training unit on the college campus. As a result, the man who graduated from an institution sponsoring an infantry unit, and who subsequently became a professional physicist, was carried on the rolls as an infantry officer. Interest in the Reserve was at a low ebb between the wars, particularly among scientists, because of social trends and the routine nature of the usual Reserve activities. Although considerable numbers of the Reservists apparently obtained transfers into more technical work, so far as the general body of science was concerned the Reserve program was not a success. If properly implemented, the program now being established for professional scientists and engineers by the Research and Development Group should solve this problem for the Department of the Army and the situation revealed in table XVI should not recur (see app. IV).

Utilization of Officers Commissioned Direct. Scientists who entered the Service by means of direct commission were rather well utilized. Slightly more than three-fourths of them used their technical background in some way during their period of service. Certainly this should be expected, since most of these individuals were given commissions for specific jobs and specialties. It is true that the exigencies of a wartime situation often prevented utilization of the individual officer in the type of endeavor which he had been promised at the time of the commissioning interview. However, if the utilization record had been as good for scientists inducted by all methods of entry as it was for those commissioned direct, this present study would not have been necessary.

There is no doubt that the scientists who held nontechnical positions performed important military functions. It is also apparent from the comments of the respondents that most scientists retained in the ranks used only a small fraction of their technical competence, and many used it not at all.

Desirability of Nontechnical Usage of Scientists. The decision as to whether malutilization of more than one-third of the scientists in uniform represented a desirable condition must be based on the answer to several questions; namely—

1. Were there enough scientists in the United States to perform all the professional technical jobs (both military and civilian) which needed to be done?

There are no quantitative data pertinent to this question. The opinions of leaders in both civilian and military activities indicate that an adequate number of the right kinds of scientists was never available.

2. Were the technical positions in civilian and military agencies adequately filled by men of appropriate technical competence for the requirements of the jobs?

In the civilian agencies and in industry, properly trained men became so scarce that positions often were filled by men without sufficient specialized training or experience. As the war progressed, the civilian scientific component became smaller, and great difficulty was experienced in filling even scientific positions directly supporting the military effort.

Respondents to this survey report that within the Services many technical positions were filled by men with inadequate technical training or experience. At the same time, the Services were seeking technical assistance and personnel from civilian agencies such as the Office of Scientific Research and Development. They also found it necessary to train large numbers of men to fill technical positions. Because of the necessity for acceleration in this training, it was often inadequate. If proper assignments had been given to the technically competent men who had been placed in nontechnical positions, much of this training would have been unnecessary.

3. Was full advantage taken by the military services of the potential applications of scientists or scientific technology to establish more effective technical military procedures?

Both civilian scientists and those who experienced military service *report* that the Services did not take full advantage of the technology available to them during World War II. This survey indicates that the Services failed to use profitably the potential technical contributions to military acitivities of more than one-third of the scientists in uniform.

In view of these conclusions—that is, that the supply of available civilian scientists was insufficient to fill all requirements adequately, that technical military positions were not all adequately filled, and that technical military activities suffered from incomplete application of technology—it seems reasonable to conclude that the poor technical utilization of several thousand scientists in uniform was definitely undesirable.

Conclusions. It might be concluded from table XVI that professional scientists should not be subject to a *nonscientific* draft which fails to take into account the requirements of the war effort for men with scientific training and experience. The table also points to the

necessity for a more realistic program for Reservists, and for somewhat greater care in the allocation of officers commissioned direct.

Utilization of Scientists on the Basis of Educational Level

Table XVII summarizes the utilization of scientists in accordance with their educational levels. Because of the irregular distribution of graduate degrees in the various scientific fields, as shown in table VII, a table of this type is indicative only of a general pattern. For example, there is no apparent reason why scientists with no college work in a particular field should have been better used than those with formal degrees, yet this appears to be the case. It is obvious that the variables which influenced this situation include the age of the individual; the method by which he entered the Service; the situation in which he happened to serve; the immediate demand for a person with his qualifications at the time of or subsequent to his entry into the Service; and the pressure which might have been imposed by friends or professional colleagues to secure his assignment to more appropriate positions.

In general, if one considers only those with formal degrees (Ph. D., M. S. and B. S. in table XVII), there is a fairly good pattern, with the highest utilization, as would be expected, among those holding the doctorate.

Table XVII. Utilization of Scientists by the Armed Forces, Distributed on the Basis of Their Educational Level

Degree of Utilization	Total		Educational Level									
			Doctorate		Master		Bachelor		Incomplete College		No College	
	Number	Percent *	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	4, 398	30. 0	945	43. 2	896	30. 2	1, 742	24. 7	525	27. 3	290	54. 4
2	2, 204	15. 0	395	18. 1	480	16. 1	1, 013	14. 4	284	14. 8	32	6. 0
3	2, 668	18. 2	270	12. 3	489	16. 4	1, 414	20. 0	448	23. 3	47	8. 8
4	2, 003	13. 6	210	9. 6	406	13. 7	1, 039	14. 7	288	15. 0	60	19. 6
5	3, 403	23. 2	364	16. 7	701	23. 6	1, 856	26. 2	377	19. 6	105	11. 2
Total	14, 676	100. 0	2, 184	100. 0	2, 972	100. 0	7, 064	100. 0	1, 922	100. 0	534	100. 0

* Percent figures are percents of the Educational Level (column) totals.

Section III. COMPARISON OF CIVILIAN AND MILITARY UTILIZATION

Introduction

It has been well established that many students who major in one of the scientific or engineering fields at the undergraduate level, do not utilize this specialty professionally. To a lesser degree this is also true of men who have secured advanced degrees in one of these fields. In the latter case, however, divergence from the field of special training and competence often has occurred because employment is not available. For example, during the late depression many persons trained in technical specialties diverted their efforts to other fields. Subsequently they failed to return to scientific work because they had become established in some other form of endeavor, and had lost some of their competence in the technical field. Some engineers and scientists also divert their efforts into technical sales or various types of administration, particularly as they reach levels of employment where a continuation in the strictly technical aspects of business places a ceiling on salary or organizational advancement. Thus scientists in universities accept positions as deans or presidents; scientists in industry occasionally become directors of laboratories or vice presidents in charge of research.

The extent of this divergence from strictly technical employment is not known. Estimates made by persons in industrial and academic life place the order of magnitude at approximately 10 percent. In almost all cases, under normal conditions, the shift of emphasis is made because it is of advantage to the individual to make the change.

Study by American Society of Mechanical Engineers and American Society of Civil Engineers

No attempt was made in this survey to question the respondents in the seven basic science fields as to their civilian utilization, in contrast with that while in uniform. These questions were included in the engineer circularization, however, and approximately 5,000 civil and mechanical engineers made a response. Conclusions drawn from these data by the American Society of Mechanical Engineers are as follows:

> The answers reveal conclusively that the best utilization of these engineers' technical and professional training and experience was not made in either their military or civilian wartime service.

It is worthy of note that 94 percent of the members of the two engineering societies who reported civilian experience during the war

considered that they were satisfactorily utilizing their technical background during their civilian employment, and 75 percent believed that they used their highest skills. In contrast, those in military service reported approximately 75 percent relatively satisfactory utilization and only 34 percent reported use throughout their period of service at their level of competence. Data are not available to show whether this was caused by inadequate attention to their proper placement, or by absence of a sufficient number of specialized positions in the Services.

In table XVIII the utilization of civil and mechanical engineers in uniform is compared with the utilization of those employed as civilians during the war period. The table shows the basic differences in utilization of the two groups—military and civilian. The percentage figures for engineers in uniform are based upon 5,203 cases, while those for engineers employed as civilians during the war period are based upon 9,562 cases. The marked contrast in utilization is all the more noteworthy when it is pointed out that the larger civilian group includes most of those who were in the military group. Hence these figures generally represent the opinions of one and the same group of men. The mutually inclusive characteristic of the two groups is explained by the fact that practically all of the engineers who were in uniform during the war period also had civilian experience during the war period either prior to their induction or immediately following their release from military service.

Table XVIII. Utilization of Engineers in Uniform Compared with Utilization of Engineers Employed as Civilians

Utilization Category	Engineers in Uniform (percent)	Engineers Employed as Civilians (percent)
1	33. 9	74. 9
2	16. 2	11. 2
3	23. 4	8. 2
4	13. 4	2. 7
5	13. 1	3. 0

Section IV. RECOMMENDATIONS AND OPINIONS OF SCIENTISTS IN UNIFORM

Introduction

A portion of each questionnaire answered by respondents who reported military service referred to the experience of the individual in terms of the utilization of his technical background while in uniform. For example, the questionnaire sent to all members of the American Chemical Society asked—

a. Give comments on your military service with reference to—
   (1) Effectiveness of your chemical work in World War II.
   (2) Suggestions for better utilization of chemists in time of national emergency.

Large numbers of the respondents submitted replies to those questions (see app. I). Unfortunately, a very considerable percentage of them confined their replies to personal histories. Approximately 4,800 individuals gave constructive, thoughtful answers which have been classified and summarized in tables XIX and XX. The pattern of summarization is divided into two major categories, namely, (1) Utilization and (2) Organization and Procedures. This pattern was devised through original analysis of approximately one thousand opinions and was found subsequently to include all the variations of comment submitted.

Comments Concerning Utilization

Assignment and Supervision. More than one-half of the respondents emphasize the need for better methods of assignment or supervision of technical personnel in uniform. The emphasis varied from 80 percent of the respondents in the field of biology to 35 percent in the fields of geology and psychology.

The comments which fall within this particular category of opinion vary widely. A 35-year-old engineer with 3 years' military service writes: "In my candid opinion the personnel system was so preoccupied with making out records and reports that any classification accomplished was purely accidental." This type of comment is *not included* in the tabulation of tables XIX and XX but is an example of the somewhat immoderate comments submitted by a considerable number of the respondents.

A Ph. D. chemist who entered through the Reserve and held the rank of lieutenant colonel comments as follows:

> "Men were sent from the United States to the theater to fill specific positions for which they were not qualified either by education, or temperament, or both.

"I believe the main weakness in utilizing the chemists was the absence of a proper evaluation of the education and ability that were needed for a particular assignment, and an inadequate system of classification according to ability and training."

In this case he is stressing a point mentioned by large numbers of respondents: That classification was not carried out by men who were themselves qualified to evaluate the professional competence of the scientists and engineers whom they were required to assign.

A professional biologist who holds the M. S. degree and experienced 3½ years of military service writes:

"Classification is not just an initial instrument in placing personnel in any organization, but is a constant evaluation of personnel. Unless this constant evaluation of personnel is carefully considered, no organization can function at its best, nor can the personnel give their fullest."

Table XIX. Suggestions for Better Wartime Utilization of Scientists and Technologists

Utilization Suggestion	Frequency of Occurrence	Percent of Men Making Suggestion*
A. On a national scale:		
1. Use in a technical capacity wherever needed—civilian or military	281	9. 0
2. Use only as civilians	596	19. 1
B. Within the Armed Services:		
1. If in uniform, use only in a technical capacity	65	2. 1
a. Furnish assignments to technical activities and assign scientifically competent supervisors	2, 524	81. 0
b. Use in technical liaison capacity	9	. 3
c. Make provision for transfer or release for better technical usage	264	8. 5
2. Use as scientific consultants, technical representatives, etc	65	2. 1
3. Use without reference to technical qualifications	119	3. 8
C. Set up an impartial board—military and civilian—to hear appeals from nonutilization practices	10	. 3
D. Assign rank on the basis of technical competence, training and experience—not on the basis of age and seniority	49	1. 6
E. Miscellaneous and not elsewhere classified	101	3. 2
Total Number of Suggestions	4, 083	
Total Number of Men Who Made Suggestions (3,115)		

*Percent figures are based upon the total number of men (3,115) who made utilization suggestions. Some respondents made more than one usable suggestion as indicated by the fact that the total number of suggestions exceeds the total number of men who made them.

The writer is confusing classification with personnel management. Yet the basic principle which he expresses is supported by many comments of a similar type indicating that many men were assigned initially or were subsequently reassigned arbitrarily without reference to their experience and training. Some scientists who were originally misassigned were enabled through their own efforts, or the efforts of friends, to secure assignments more properly calculated to use their training and experience. One or two scientific organizations established offices in Washington just for this purpose.

The difficulties of proper technical supervision and adequate technical working conditions plagued the services during the war and still have not been solved. An M. S. physicist who held the rank of major and entered the service from the Reserve writes:

> "Work in rocket development was handicapped by: (1) Weak personnel policy. Effectiveness could have been multiplied by securing adequately trained and a sufficient number of officers and civilians; (2) Low priority assigned research by higher staffs. Delays on small items vital for progress of research lost months in almost every project; (3) Insufficient liaison between the Service and the research groups on the over-all planning of weapons, their detailed characteristics, production engineering, demonstration in the field, and the tactical training of troops in their use."

An experienced mechanical engineer who had been drafted describes his experience as follows:

> "The primary fault with the utilization of my own and others' skills was psychological. We were assigned to work with civilian employees who were paid $300–$400 per month for doing identical work while we were getting $50 per month. (Some were given technical ratings.) Officers in charge of our company were not qualified to handle such a group of men. They acted as if we were a group of infantry recruits (I was in Infantry for 6 months). That is not conducive to best work.
>
> "Any man in the company could have handled the officer's work of administration in his spare time and handled his technical job too, yet the officers had better living conditions and pay. All of the above conditions contributed to inefficient use of our skills."

These are indicative of more than 2,500 similar comments which state that inadequate personnel operations resulted in assignments and supervision which all too often vitiated the effectiveness of the actual classification system.

Utilization as Civilians. The second largest category of opinion concerning utilization suggested that scientists and engineers should be used only as civilians during a period of hostilities. Many of these men felt very strongly that professionally trained scientists and engineers could make a much greater contribution to the national welfare as civilians working on research and development projects

than as officers or enlisted men in uniform. Some of the comments were vitriolic and bitter; large numbers marshaled arguments carefully; but all lost sight of the fact that *any future war will require within the Services a large group of technically trained officers of high skill to function in research, planning and operations.*

National Utilization. The third category of utilization opinions dealt with general utilization on a national scale. In this, scientists pointed out that they could make their maximum contribution to any wartime situation either as civilians or as military personnel only if they were utilized in technical capacities. This reflects the rather natural opinion of the professional scientist and engineer that research and development, and the production or operation of technical equipment, are essential to national defense; that because the scientist's life is spent in this endeavor it represents his highest skill and is the field from which he can make his highest contribution.

Transfer Within the Services. Another large series of recommendations concerning utilization dealt with the matter of transfer within the military system or release from military service in order to insure better technical utilization of the individual. Many respondents reported that they had been assigned to relatively nontechnical duties at the same time that the Services were recruiting professional scientists and engineers through publicity campaigns, but that their requests for transfer to these more technical branches were refused by commanding officers. The record indicates that many scientists and engineers made competent administrative officers and were useful in these positions. The basic question to be answered is whether it is better to utilize the scientist as a scientist because he is always in short supply, or to use him as an "administrator," adequate preparation for which does not require from 4 to 7 years of education plus considerable technical experience.

A typical comment pertinent to this point is made by a captain in the Reserve Corps who had previously had several years of industrial experience as a chemical engineer. He states:

> "No technical man should be placed in field service in command of troops. Any intelligent nontechnical man can be trained to do this work. The best place for chemists and chemical engineers is to remain in industry and chemical warfare research."

A lieutenant colonel, Reserve, with graduate degrees in chemistry and with 18 years of previous industrial experience as a chief chemist, expresses the same opinion when he says:

> "Have more officers previously trained for administrative work, and save technical men for technical work."

Technical Training Programs. A considerable number of comments were offered concerning the malutilization of fully trained and experienced scientists concurrent with Service operation of training programs in these same fields. In addition, rather numerous comments

mentioned the nature of the training and the caliber of instruction in training courses operated by the Services. A comment from a psychologist, who was drafted and after 4 years of service left the Army as a first lieutenant, is as follows:

"The clinical psychology school I attended contained a very diverse lot of people who were assembled on last-minute orders to become 'psychologists,' while qualified personnel were serving somewhere else as everything from war bond officers to infantrymen."

Another comment by an experienced occupational analyst states that the preparation of interviewers expected to do effective occupational classification normally involved 1 day's training in the use of the Dictionary of Occupational Titles.

Rank Based on Technical Competence. The assignment of rank based on technical competence was brought out in a number of comments and opinions because in a military organization it is generally considered that rank is proportional to competence. Unfortunately, rank often had little to do with technical capabilities. Scientists report that technical programs often suffered because the professional scientists held rank considerably lower than the officers with administrative duties who often made the final decisions effecting the technical work. A psychologist with 5 years of service who entered through the Reserve and held the rank of lieutenant colonel phrases it in this way:

"As progress in rank was maintained, more and more administration activities were expected with resultant loss of time spent on specific research and psychological problems. It appeared generally true in the Army that research itself was undertaken by those of 'low' rank. This worked hardships both on those doing the research and those qualified to do research but in administrative positions. More adequate provision for advancement of the research worker is necessary."

Another psychologist with 4 years of service summarized his experience in this regard as follows:

"The other chief deterrent to efficient use of psychological service that I noted was the refusal to assign rank in proportion to the job called for in psychological work.

"It is an axiom in the Service that, no matter what a person's training and skills are, he is useless without corresponding rank. A competent man who is a private cannot use his training effectively in a special training unit, for example, as many less fortunate men than myself were forced to do.

"Similarly, a second lieutenant clinical psychologist on a general hospital staff sitting in conference on a patient with a group of doctors whose lowest rank is a captaincy cannot operate effectively in his field. His value tends to be identified with his rank and his opinions carry only as much weight as the insignia he wears."

These are characteristic comments.

Use of Enlisted Men. The utilization of enlisted men who are competent scientists and engineers, but for some reason cannot be commissioned, presents even further difficulties which are discussed by a drafted mechanical engineer holding an M. S. from the California Institute of Technology. He writes:

"The Navy did not have any suitable system established by which suitable use could be made of enlisted men with professional experience—as opposed to the recognition of persons without professional experience but with trade background, such as carpenters, mechanics, etc.

"The Navy did not show an interest or desire to correct the above-mentioned fault in their system.

"The only way in which an enlisted man with professional standing could obtain work in his own field was by his own initiative (this is not only evidenced by my own case but by several others which came to my knowledge).

"The delegation of responsibility to carry out technical projects without suitable authority served to delay the completion of military projects and contributed to further inefficiency in the use of technical knowledge and experience gained in civilian life."

It is believed that no *really competent professional scientist* should be retained in the ranks during his period of military service. If he cannot be commissioned, he should be returned to civilian life where he can make a contribution to the progress of the war commensurate with his training and experience.

Assignment of Reserve Officers. The failure of the Organized Reserve Corps to operate effectively in the proper placement of scientists and engineers who held Reserve commissions is evidenced by the large percentage of Reserve officers who failed to utilize their technical competence while in uniform. A considerable number of thoughtful comments concerning this situation were made by respondents to the survey, most of whom suggested reassignment and technical military training of the Reserve officer scientist. A biologist holding the Ph. D. degree who was a major in the Reserve writes as follows:

"I have reason to believe that my training in biology was most effectively utilized both with respect to my own benefit and to the furtherance of the war effort.

"The assignment which I enjoyed during my tour of active duty was largely the result of my own efforts; that is, I was called to active duty in the Medical Administration Corps Reserve and was scheduled to take inventories, run the post exchanges, and other similar nonscientific tasks for a 500-bed hospital in New Jersey. It was only through the efforts of wiser men in the Office of The Surgeon General (*whom I went to see*) that I was assigned to a post where my scientific training could be utilized. Had I not made an effort to call attention to my training and had I not sought these

personal interviews, then I would have been just as woefully misplaced as many of my colleagues."

A biochemist holding the Ph. D. and a Reserve commission of captain, gives the following personal example. It is similar to the comments of other Reserve officers who were not too active in Reserve affairs between World War I and II.

"In determining an individual's assignment, professional training and experience are more important than limited amounts of training in some military field which he had in the past. He has spent a large amount of time on the former, and only a little time on the latter.

"*Example:* Before World War II, I was commissioned in the Engineer Reserve because I took ROTC in that branch. Later I did postgraduate work in biochemistry and bacteriology, fields not closely connected with engineering. When ordered to active duty, I was not assigned to any technical work, although there was supposed to be a crying need for biochemists and bacteriologists in the Medical Department, and some other branches. It was many weeks before I was able to be relieved from duty with Engineer troops and detailed to the Sanitary Corps."

A Ph. D. physicist who entered service from the Reserve expressed his opinion as follows:

"My training in physics was almost completely ineffective, even though I made repeated attempts to transfer into some phase of the military work that would utilize it.

"Based on my experiences, one should have no connection with any Reserve military organization if he expects to have any application of his professional training in physics during a national emergency. Under present conditions of weapon development the military organizations should have physicists on their staffs, but I certainly do not recommend the procedure to any physicist."

A second physicist Ph. D., who also entered from the Reserve, saw 5 years of service and ended the war as a lieutenant colonel, makes the following comment:

"My physics work was not effective.

". . . . . be prepared to get the Reserve group into the proper positions and at work with a minimum delay in time of emergency. Unless something of this nature is done, men with advanced degrees will refuse Reserve commissions. They saw too much waste of skills in the last war."

In general, the concept of utilization expressed by these respondents is summarized in simplified form by a professor of chemistry from a southern university who states his feelings in the following words:

"Put chemists to work on chemical problems."

Physical Qualifications for Technical Assignments. The matter of physical qualifications was also commented upon by numbers of respondents. They pointed out that if they were sufficiently well qualified physically to be drafted into combat units, they should certainly be physically qualified to utilize their technical competence in military positions very similar to those they had been filling adequately in civilian life.

This was discussed by one mature engineer who was drafted and spent 2 years in the Navy performing no technical work. Immediately prior to his induction he had been the chief engineer on a multi-million dollar construction project contracted for by one of the Armed Services. Without complaining, he indicated that he had made no contribution as an enlisted man, and that the rigid physical qualifications prevented his being commissioned although he was physically capable of performing normal duties. A geologist who was drafted, although partially blind in one eye, and who by some strange chance ended his military career as a captain, makes the following comment:

> "It is my opinion that the services were inclined to arbitrarily set up nonessential requirements (such as physical, age, etc.) for technical men and, by rigidly and occasionally blindly adhering to them, lost to our country the services of many excellently qualified persons."

It would seem reasonable to assign competent scientists not physically fit for combat duty to technical positions commensurate with their training and experience in the zone of interior, or in noncombat area overseas. This would release the younger and physically fit officers, or the older physically fit and militarily experienced officers for semicombat or combat service, and probably would result in a more effective technical program and a larger number of men available to the combat echelons.

Other Comments. Other suggestions for utilization are concerned with the assignment of rank on the basis of technical competence, training, and experience, instead of on the basis of age and seniority; the use of scientists as scientific consultants; or the simple statement that, if in uniform, all scientists should be used in a technical capacity. One small group would recommend use wherever needed without reference to technical qualifications.

Comments Concerning Organization or Procedures

This category of opinion is summarized in table XIX. The suggestions apply to or deal with organization or procedures which might be established to allocate scientific manpower either on a national scale or within the armed services.

Use of World War II Selective Service System. It is significant that a *total of only 2 men* out of the 4,772 recommend use of the Selective

Service System as it operated during World War II. By contrast, more than half the respondents suggest some form of assignment system. Although the suggestions fall into a considerable number of minor categories, almost all of them call for some form of pooling and central allocation of scientists through utilization of civilian, military, or technical agencies, or combinations of all three. An entomologist holding a Ph. D. degree, with several years' experience on the faculty of a State university, and holding a Reserve commission of captain gives the following comment:

> "Obtained commission in the Reserve (Coast Artillery) upon graduation from college. In spring of 1942 tried to transfer to Sanitary Corps but was unable to do so. Upon separation received commission in Sanitary Corps because I refused to accept commission in any other branch.

Table XX. Suggestions Concerning Organization and Procedures for Better Allocation and Use of Scientists and Technologists

Organization and Procedure Suggestion	Frequency of Occurrence	Percent of Men Making Suggestion*
A. Use present Selective Service System	2	0. 1
B. Use a new system for allocation:		
1. A central pool and/or the National Roster	462	27. 9
2. Use the technical and scientific societies	166	10. 0
3. Establish a new civilian agency	206	12. 4
4. Use the military establishment	91	5. 5
5. Use a joint civil/military board	77	4. 6
6. Commission all technical personnel directly (reserve or direct commission)	162	9. 8
7. Modify Selective Service to make it really scientific	185	11. 2
C. Establish National Service	124	7. 5
D. Use scientifically trained individuals for military classification	61	3. 7
E. The Military Establishment must recognize the value of scientific research and train Reserves during peacetime for technical military assignments	300	18. 1
F. During peace, review qualifications of all technically trained Reserves and transfer into Corps appropriate to technical training and experience	217	13. 1
G. Assign school graduates to a Corps on basis of academic specialization rather than on basis of type of ROTC unit in the school	38	2. 3
H. Miscellaneous and not elsewhere classified	85	5. 1
Total Number of Suggestions	2, 176	
Total Number of Men Who Made Suggestions, 1,657.		

*Percent figures are based upon the total number of men (1,657) who made organization and procedure suggestions. Some respondents made more than one usable suggestion as indicated by the fact that the total number of suggestions exceeds the total number of men who made them.

"Avoid mass exemptions for all who happen to hold a technical degree; provide for separate classification of technical men on their individual qualifications by local or regional boards drawn from leaders in the profession. The jurisdiction over individuals so classified would be taken from the local draft boards.

"Adopt the principle that men of military age should be engaged in work with a direct connection with the war effort and that they should be assigned wherever they can be most useful. Pay scale, hours, and liability of transfer on short notice should be comparable with that of Army and Navy officers of similar age, experience, and responsibility. Assignments of such individuals should be reviewed regularly to make sure that they are still engaged at direct war-connected activity.

"Provide public and legal recognition of the status of all individuals so classified who are transferred from their usual civilian jobs, and protect their rights to return subsequently to their former positions."

A biologist who holds a Ph. D. degree and who was directly commissioned during the war makes the following suggestion:

"In time of a national emergency have all plant pathologists (and other scientists) who are subject to Selective Service register with a Scientific Selective Service Board. They would then be delegated according to their qualifications and the relative need for their services to new technical assignments (military or civilian), to regular military duty, or to remain in their current position. The Scientific Selective Service Board, whether on a local, State or national basis, must include competent, mature, broad-minded scientists among its members."

A physicist who entered the Army through the Organized Reserve comments that:

"In view of my educational level, fullest practicable use was made of my technical training in the Army, due primarily, however, to my own initiative in getting assigned to radar work as a Reserve officer, when it was still possible for an individual to exert influence on his own duty assignment.

"A civilian technical agency, in time of war, should coordinate and direct the assignment of technical and engineering personnel among all activities: Government research agencies, industry, and Armed Forces."

A geologist makes a comment equally applicable to other fields of science as follows:

"Would suggest: 1. That agencies, both civilian and Service, which are responsible for mobilization of manpower be more fully advised of the capabilities of geologists and their possible work not only in geology but in other sciences. 2. Some agency should be

made responsible for estimating national needs for scientists and placing them in effective positions. 3. Service personnel should carry specialty numbers indicating civilian as well as Service training and experience. Serious effort should be made to place personnel in work corresponding to these specialty numbers."

The fact that so large a portion of the constructive comments and suggestions mention the use of some variety of a central pool suggests that this would meet with favor with most scientists, if they were assured that the allocation would be made in line with the technical needs of the Armed Forces and the Nation.

Reserve Program for Scientists. One of the largest groups of opinion is concerned with the organization of the Organized Reserve Corps and review of the classification of technically trained Reservists. More than 500 scientists made suggestions to these points. Others recommended that assignment of college graduates who receive Reserve commissions through college ROTC training should be made on the basis of their field of specialization rather than to the basic branch represented by the ROTC unit at their college of graduation. A lieutenant colonel of Reserves with a doctorate degree in psychology writes:

"Extremely little use was made of psychological training. Because of ROTC training in Field Artillery, all attempts to transfer to possible use of professional training were refused. Apparently little attempt at analyzing Reserve officers for best use during active duty in the emergency (was made)."

Conclusion

Appendix I contains the full text of the opinions and recommendations partially quoted in the preceding pages, and a number of additional recommendations considered to be of interest. In general, it might be said that the opinions and recommendations submitted by the respondents corroborate and complement the statistical results of the survey. Both call for constructive and realistic action.

APPENDIX I

COMMENTS AND RECOMMENDATIONS OF RESPONDENTS WHO EXPERIENCED MILITARY SERVICE

A considerable number of the comments and recommendations submitted by respondents to the survey were thoughtfully and carefully written. These represent the thinking of scientists with extensive military experience, most of whom served in commissioned grades. A number of the comments are reproduced verbatim in this appendix to illustrate the character of the individual suggestions which were offered.

The quotations deal with the following subjects in the order listed below:

1. National allocation and assignment of scientific manpower (pp. 73–78).
2. The organization and implementation of scientific work within the Military Establishment (pp. 78–82).
3. Administration and supervision of the technical activities of the Military Establishment (pp. 82–83).
4. Classification and training of scientific manpower in uniform (pp. 83–85).
5. Types of assignments and method of assignment for scientific manpower in uniform (pp. 85–89).
6. Organized Reserve program for scientists and engineers (pp. 89–90).
7. Physical qualifications necessary for military service (p. 90).

National Allocation and Assignment

1. Chemist, B. S., direct commission, Army, first lieutenant:

I believe that any future Selective Service legislation that may be necessary should—

Avoid mass exemptions for all who happen to hold a technical degree.

Provide for separate classification of technical men on their individual qualifications by local or regional boards drawn from leaders in the profession. The jurisdiction over individuals so classified would be taken from the local draft boards.

Adopt the principle that men of military age should be engaged in work with a direct connection with the war effort and that they should be assigned wher-

ever they can be most useful. Pay scale, hours, and liability of transfer on short notice should be comparable with those of Army and Navy officers of similar age and experience and responsibility. Assignments of such individuals should be reviewed regularly to make sure that they are still engaged at direct war-connected activity.

Provide public and legal recognition of the status of all individuals so classified who are transferred from their usual civilian jobs, and protect their rights to return subsequently to their former positions.

2. Chemical engineer, Ph. D., Reserve, Army, captain:

To eliminate the national disgrace that necessitated draft dodging on a widespread scale to get and to retain professional personnel of all classes in their most valuable positions, and at the same time to supply the legitimate needs of the Services for such personnel, it is suggested that—

All personnel in a professional capacity be completely exempted from control by the "local board" after proof of their certification to a "National Roster" is established. Professional societies to establish adequate definitions.

Professional personnel be made responsible for policing their own house. Local professional board to be responsible for periodic revision or certification of "no change" in status to National Roster.

Armed Services be authorized to draft professional personnel for specific assignment to professional occupations only, utilizing draft by lot according to job specification from a National Roster. Subsequent change in assignment to be subject to review on request of individual; review by civilian professional board.

Students in professional fields at the college and graduate levels be allowed to continue regular program, subject only to quality of work.

3. Geologist, M. S., enlisted, Air Force, first lieutenant:

Would suggest—

That agencies, both civilian and service, which are responsible for mobilization of manpower, be more fully advised of the capabilities of geologists and their possible work not only in geology but in other sciences.

Some agency should be made responsible for estimating national needs for scientists and placing them in such a position as to prevent services from "grabbing" them and placing them in ineffective positions.

Service personnel should carry specialty numbers indicating civilian as well as Service training and experience. Serious effort should be made to place personnel in work corresponding to these specialty numbers.

4. Biologist (plant physiologist), Ph. D., drafted, captain:

Maintain an active roster of scientifically trained personnel and channel military needs through it from the very beginning of an emergency; by that I mean to include from the very first any future drafts of civilians. Many scientists were drafted early and were given no subsequent consideration for use of their scientific training or experience although the military need was great for that type of training. The policy was to obtain scientific help from those without Army connection even though a survey in the Army would probably have gone a long way toward satisfying the demand. Needless to say this was not efficient use of personnel at hand.

For scientists (for potential military needs) I would propose a National Scientific Draft Board composed of scientists representing the various fields to select and provide personnel for the scientific needs of the Military. Anyone eligible to be registered with the Scientific Draft Board would be allocated by them after the presentation of the scientific need by the Military. Registration with the

Scientific Draft Board would satisfy any national registration requirements. In this way scientific personnel could be wisely and efficiently allotted as the need arose without running the risk of indiscriminate drafting as happened recently, and subsequent near exhaustion of scientific personnel so urgently needed for the health of the national economy.

At the present time, and for want of other remedies, should an emergency arise I think it would be wise to have scientific workers engaged for Military needs to be channelled direct through scientific administrative channels rather than the Military, at least to a very high advisory level—the Army way and the scientific way do not always agree.

5. Biologist (plant physiology), B. S., Reserve, major:

As I was in the military service at an early date, my status gave me no difficulty, but I noticed from contacts with friends of draft age with training including or close to Ph.D. in botany or plant physiology that they had two principal choices: (1) enter the Service, usually with no view of using their scientific training, or (2) by hook or crook become connected with a project such as Guayule Research, Rubber Development, or the like, which rated as an essential wartime project.

The difficulty in the set-up lay in the fact that many capable men chose course (1) to avoid any possible stigma of Service evasion; while in other cases men of mediocre ability or training rushed to take advantage of course (2).

It appears to me that in case of another national emergency, there should be procurement of biologists on a national scale to fill the necessary essential research positions, as well as to funnel already trained biologists into branches of the Service such as Sanitary Corps and Medical Corps (including MAC), where, in the war just past, men with this background were often hurriedly trained and used.

If such procurement is to be effective, it will have to be a part of the Selective Service System, or work with complete cooperation of the latter.

6. Physicist, M. S., draft, Army, second lieutenant:

Where my physics was used it was the result of coincidence. As far as I know no military assignment was given me because of my technical training. My transfer to Signal Corps was the result of my own initiative, as was my enrollment in communications training. Total effectiveness of my physics was *slight.*

A single, authoritative "roster" of some kind should thoroughly investigate all physicists and virtually draft them for needed work. Selective Service should keeps hands off men cooperating with such a "draft."

7. Physicist, Ph. D., draft, Army, Tech 5:

Basic medical training Dec 43–Apr 44; miscellaneous replacement camps and POE Apr–July 44; replacement camp APO 502, San Francisco, July–Sept 44; 68th Med Depot Company APO 709 from Sept 44–Jan 45 (had now and then a little use for my manual dexterity and acquaintance with different types of instruments); 6th Med Laboratory, APO 709, Jan–Aug 45 (what I learned in high school chemistry was ample for what I needed); radio station WVUQ, APO 709, transmitter attendant and maintenance man (the fact that I knew the theory helped me get that assignment but I could do all those things I had to without my formal education, and so could probably everybody who could get through Junior High and had a little interest in technical matters).

Remove physicists, chemists, etc., from draft board jurisdiction completely; I was not the only one who was sent on active duty entailing factually a loss to production. It seems to me that all scientific workers should be under direct control of National Roster (War Manpower Commission, resp.) and War Department (Navy Dept.) (resp.) only. Assignments should not be left to clerks in reception centers, replacement camps, etc., but handled directly by the above

agencies. Whether or not I wear the uniform would not in fact, and shouldn't, make any difference. We will perhaps not have time in the next war to change from civilian wear to uniforms. Acceptance of those assignments can and should be compulsory, regardless of civilian status. Present files of the National Roster should be kept up to date by requesting from colleges, universities, etc., lists of the graduates in the technical fields.

8. Physicist, B. S., Reserve, Army, captain:

In view of my educational level, fullest practicable use was made of my technical training in the Army, due primarily, however, to my own initiative in getting assigned to radar work as a Reserve officer, when it was still possible for an individual to exert influence on his own duty assignment.

A civilian technical agency, in time of war, should coordinate and direct the assignment of technical and engineering personnel among all activities: Government research agencies, industry, and Armed Forces.

9. Biologist (phytopathologist), Ph. D., direct commission, Navy, lieutenant (j. g.):

Roster of all plant pathologists and their qualifications be made available *now* to the military and JRDB.

Representative plant pathologists in cooperation with representatives of Army and Navy research and development staffs prepare a list now of assignments (military and civilian) that could be most adequately filled by plant pathologists in time of a national emergency.

In time of a national emergency have all plant pathologists (and other scientists) who are subject to Selective Service register with a Scientific Selective Service Board. They would then be delegated according to their qualifications and the relative need for their services to one of the assignments (military or civilian) on the list proposed in (2) above, to regular military duty, or to remain in their current position. The Scientific Selective Service Board, whether on a local, State, or national basis, must include competent, mature, broadminded scientists, among its members.

10. Physicist, incomplete college, draft, Army, first lieutenant:

For extreme speed which may be necessary, would *suggest assignment during peacetime of scientists and engineers to their line of work* and branch of service. Issue to men official qualification cards (which could be corrected from time to time) stating man's training and principal fields. If there is time for customary inductions, choose intelligent, well-informed interviewers, to secure reasonably correct placement.

11. Physicist, M. S., direct commission, Navy, lieutenant:

Solving administrative problems was always more urgent than any direct application of physics through study of the technical implications of the work. Time for the latter activity was almost never available, after routine requirements were met. The technical factors actually germane to the necessary administrative decisions were so simple that, even as background, the value of physics training was not high.

The Armed Forces must realize that a physicist in uniform can never be very effective as a physicist. Nevertheless, every physicist should, in wartime, always be allowed freedom to join the service on any terms available to him, if he wishes to. When a physicist receives his initial occupational deferment, he should be credited to the local quota just as if inducted; thereafter the local board should have no more concern; renewals of deferments should be handled by a regional S. S. Board dealing exclusively with persons qualified for scientific work.

12. Mechanical engineer, B. S., drafted, Navy:

I believe that the Government should set up an engineering agency with training and qualification records of all engineers in the United States, classified in their particular field. These records would be brought up to date each year. Through a publication of its own, or through the publications of the engineering societies, engineers could be notified of the engineering activities carried on by the Government, fields of activity where engineers are needed, etc. In preparation for a national emergency, men with the needed qualifications could be recruited for civilian or Government work. In a national emergency, each engineer entering the military service would be placed in an activity that fully utilized his abilities as shown by his training and qualification record. The abilities of those engineers that were not physically qualified for a commission but were drafted would not be wasted as happened so often in the past war.

13. Mechanical engineer, B. S., enlisted, Air Force:

In January of 1942, when I enlisted as an aviation cadet in the Army Air Forces, I had a degree in mechanical engineering and two years of experience with the Corps of Engineers in hopper dredge operation and maintenance. Along with hundreds of other engineers I went through the aircraft maintenance training course at Chanute Field, Illinois, and became an officer in that specialty. From my observations of the subsequent military careers of myself and my fellows and my knowledge of the requirements of industry during this crucial period, I have come to the conclusion that this recruiting and wastage of key manpower was a disgraceful blunder.

There were, I believe, some 275 tactical air groups in the AAF at maximum strength, each group consisting generally of four squadrons. Each squadron, group headquarters, wing headquarters, and higher headquarters, had an engineering officer, most of whom were graduate engineers frittering away their talents. There were then approximately 1,400 technical men in the tactical forces alone, large numbers of others in airdrome and service squadrons, service and depot groups, and at general depots, and large numbers in the Air Transport, Technical Training, and Flying Training Commands. I leave out the Matériel Command on the assumption that it made better use of its men. There were probably 2,500–3,000 wasted engineers in the Army Air Forces.

The crime of it was that these men utilized perhaps 10 percent of their professional knowledge and about 50 percent of the general ability men of their caliber may be assumed to possess—this latter, unfortunately, was true of most capable men in the Army and in other cases not altogether wrongly so. The functions of the engineering officer in the tactical outfit was to supervise the maintenance of its airplanes, a job that was made routine by the Air Forces excellent systemization of method and rule of "remove and replace" rather than tinker. The ideal man for the job was a man with less education, much more practical experience, and the leadership qualities of a good foreman; in other words, a man up from the ranks.

Although some bureau in Washington (I've forgotten which) had a census of all technically trained personnel in the country, apparently little or no use was made of it. My recommendation is simply that in a national emergency the particularly valued skills of the citizenry of the Nation, for which the demand will exceed the supply, should be hoarded and allocated by a central agency to insure their fullest and most fruitful utilization.

14. Biologist (zoologist), Ph. D., Reserve, Army, major:

I have reason to believe that my training in biology was most effectively utilized both with respect to my own benefit and to the furtherance of the war effort.

The assignment which I enjoyed during my tour of active duty was largely the result of my own efforts; that is, I was called to active duty in the Medical Administrative Corps Reserve and was scheduled to take inventories, run the post exchanges, and to perform other similar nonscientific tasks for a 500-bed hospital in New Jersey. It was only through the efforts of wiser men in the Office of The Surgeon General (whom I went to see) that I was assigned to a post where my scientific training could be utilized. Had I not made an effort to call attention to my training and had I not sought these personal interviews, then I would have been just as woefully misplaced as many of my colleagues.

For a year or so prior to my entry on active duty, I had received (and filled out minutely) questionnaires from the National Roster of Scientific and Specialized Personnel. However, I did not find any member of the Armed Forces (*at that time*) who had heard of the National Roster or knew of its work. This should not be construed as a criticism of the National Roster; I was called to duty so early in the game, that it is possible that their office was not yet sufficiently organized to participate in placing personnel who were then entering on military duty. However, all through my 4 years of service, I periodically received questionnaires from the National Roster, which I faithfully filled out, which continued to ask the same routine questions such as: "What is your present draft status?" "Would you be willing to serve with the Armed Forces?", etc. It was my impression that the National Roster was not adequately classifying or *using* the information they already had; I have since talked to a great number of biologists, all of whom have had somewhat the same idea, and none of whom had been placed in military service so as to utilize their professional abilities. I have no doubt but what many people were placed by the National Roster both with regard to the person's satisfaction and to the good of the war effort, but have not yet met these people. My advice would be to continue the National Roster during peacetime and to classify the information so efficiently that it will be *instantly available* when an emergency arises. The information should be kept up to date. An effort should be made *by the Military* to consult the files of the National Roster for best placement of all scientific personnel, rather than to leave the entire responsibility for placement with the National Roster.

Organization and Implementation of Scientific Work

15. Biologist (Physiologist), Ph. D., Reserve, Air Force, lieutenant colonel:

Inadequate preparation of plans of scientists for war mobilization. Lacking a united front and prearranged policies, scientists allowed themselves to be drafted almost indiscriminately, (a) robbing research departments of personnel who could serve the nation best by remaining in the laboratory, (b) automatically depleting the numbers of graduate students and teachers so that a postwar scientific personnel deficit was inevitable, and (c) entering military service with no prearranged plan for their maximal utilization in the Armed Forces.

Inadequate organization of scientists in the Armed Forces. Scientific personnel considered themselves fortunate if they received assignments which required utilization of their training and experience. Although there were many positions in the Armed Forces requiring scientific personnel prior to the war, and a tremendous number in addition appeared during the war, many of these were filled with untrained or inexperienced individuals while qualified persons were given routine nonscientific duties.

Lack of scientific personnel in the regular components of the Armed Forces. This unfortunate situation results in:

a. Inability of the armed forces to judge the methodology of investigators.
b. Inability of the armed forces to recognize important problems susceptible

to scientific investigation, and which can be answered only on the basis of such investigation.

c. Difficulty in establishing adequate liaison between the military and scientific worlds.

d. Assignment of unqualified individuals to serve as directors of laboratories. These untutored individuals frequently assume unwarranted direction, censorship, etc.

e. Inability to establish adequate research laboratories in peacetime.

f. Paucity of foreign and domestic service intelligence information.

g. Inability to implement recommendations based on research findings.

Organization of all civilian scientific bodies on a united front basis to work out with the military services an adequate war and peacetime military scientist program. Evidence that such organization is possible and effective is the action resulting from pressure by engineering groups for release of students, etc., late in World War II.

Constant scrutiny by competent civilian scientific agencies of all research activities, budgets, etc., of the armed services. These services represent, after all, the entire United States. Because their adequacy as regards personnel, matériel, etc., in wartime is dependent so completely upon the adequacy of research in peacetime, the Services should be a matter of constant concern to all persons, but especially to all scientists.

Establishment of permanent, firm liaison and cooperation between the armed services and civilian scientific bodies and persons to insure availability of consultation, constant awareness on the part of scientists of the needs of the military, complete interchange of results and ideas.

16. Physicist, M. S., Reserve, Army, major:

(1) A truly selective service policy, so that those with technical training are held in, or put into, the field where they will be of most use, and plans carried through to augment, rather than deplete, the reservoir of scientifically trained personnel. (2) The real emergency now is during the peace; the outbreak of a new war will be too late for effective use of physicists. Suggested action: A detailed and continuous analytic survey of the possibilities of weapons by scientists and Army officers, to cover secure triggered devices, control centers, the tactical use of weapons, training of Army personnel, preparations to train civilians in retaliation tactics. Continuing research and development of weapons to keep abreast of any other nation until international organization is sufficiently developed to permit its taking over, controlling war research, and making plans based on research results so that there will always be a group of nations instantly ready to reply to any attack by a single nation.

17. Chemist, Ph. D., Reserve, Army, lieutenant colonel:

From a selfish point of view, it would have been better for me, as a chemist, to have remained in chemistry during the war. From the point of view of the over-all war effort, there may be some question as to whether scientifically trained personnel should be utilized only in their chosen fields. Since my war experience is limited to Field Artillery, my remarks apply only to that branch of service; it is my opinion that the success in the technical and tactical use of field artillery weapons during the war was largely due to the high proportion of officers in that branch whose civilian training had been in one of the following fields: chemistry, physics, chemical, civil, electrical, mechanical, or communications engineering. It is common knowledge that officers with such training were generally better field artillery officers than those who had no technical civilian training. (At least that was the opinion expressed by many instructors at the Field Artillery

School.) There are many assignments in Field Artillery which can be grasped quickly and efficiently only by people with such training.

However, it is unfortunately true that even in that one small portion of the war effort, maximum use of technically trained personnel was not achieved. I believe that these remarks would also apply to other branches of the service; i. e., technically trained persons are essential to their operation, but that not all technically trained persons were advantageously used.

I believe that plans for proper utilization of all technically trained persons (not only chemists) in time of emergency must be made, and that those plans must include not only research and development, but the requirements of all the operating arms and services of the future. Undoubtedly, the majority of the personnel of future Arms and Services will not have to be technically trained, but unquestionably there will be numerous key positions that will require such training.

All scientific societies and institutions and all branches of the armed services must analyze all actual and projected requirements for trained personnel, both civilian and Military, before procurement can be discussed.

18. Chemist, Ph. D., Reserve, Army, lieutenant colonel:

Men were sent from the United States to the theater to fill specific positions for which they were not qualified either by education, or temperament, or both.

I believe the main weakness in utilizing the chemists was the absence of a proper evaluation of the education and ability that were needed for a particular assignment, and an inadequate system of classification according to ability and training. This fact is important: The men in charge of the Chemical Corps are not primarily professional chemists. This is no reflection on their ability as soldiers, but is a result of our military system.

Suggestions are offered for your consideration in an effort to utilize chemists better in the event of another emergency. They are—

For a joint committee composed of members from the interested Armed Services and from the American Chemical Society. A majority of the ACS members should be Reserve officers who saw extensive service, some in the United States and some abroad.

This committee should study the requirements for the several assignments in the Armed Services and set up personnel specifications therefor. A large number of assignments do not require chemists.

This committee should devise a rating chart for chemists which will facilitate the assignment of qualified men to the several assignments in the Armed Services.

This committee should devise a system of supplying qualified men to the Army so that all civilian phases of national defense can be carried out most advantageously and at the same time the Armed Services needs (actual need—not imaginary) will be met.

The second phase of the committee's activities should be the consideration of a plan for utilizing chemists in special projects for the armed services. Often it is advantageous to give a civilian a commission in order to facilitate his work on certain projects. Too often the man was transferred to something else, and often he was not the best qualified man to work in the new project. Then, too, qualified men have been deterred from utilizing their abilities to the best advantage because of a commanding officer who was not qualified for his highly technical command. I believe that if a chemist is commissioned to do a certain job, he should be returned to a civilian status when the special job is done, unless his special talents may be utilized as advantageously in another place. A board of military and ACS personnel should

be the placement judges, not some military personnel officer who does not have enough technical training to evaluate the job or the man.

19. Biologist (entomologist), M. A., Army, master sergeant:

Actual effectiveness was considerably less than the potential effectiveness, due to—

Lack of peacetime planning for adequate entomological participation in a global war, with the result that serious deficiencies or obstacles which easily could have been preplanned away arose in personnel, training, supply, and operation procedures that in turn hindered or prevented effective work.

Lack of cooperation on the part of both commanding officers and their men due to nonunderstanding of the role of insects in the transmission of disease.

Suggestions for the best utilization of entomologists in time of national emergency.

Foremost is the need for a continuous, active preparedness program. This involves three main aspects:

High caliber entomologists can be had in the peacetime Army only if working conditions, salary, rank, and opportunity to do worthwhile work are offered which compare favorably with civilian positions. And in wartime, especially, it is absolutely necessary that entomological work be coordinated on a high level by thoroughly competent entomologists with adequate rank, responsibility, and authority to make and have enforced the necessary technical and professional decisions.

Next to the absence of entomological Mobilization-day plans adequate for a global war, the chief impediment to effective entomological action stemmed directly from the nonexistent to inadequate high level integration of the program in the only way it could be carried out: provision of *capable entomologists* in Washington with the rank and authority to launch the program and similarly *qualified* men in theater and other high echelon headquarters to keep it going. In the past war, far too many important professional entomological decisions were made or had to be made by nonentomologists.

There should be carefully worked out over-all entomological Mobilization-day plans including up-to-the-minute tables of organization and equipment and workable procedures for obtaining men and matériel.

In achieving adequate M-day plans, Army entomologists could be aided greatly by making full use of all civilian entomological facilities. The best way of doing this would be to establish and closely maintain formal liaison with the two national entomological societies. In addition to these questionnaires it could be most helpful to ask the societies to furnish any other applicable information which may come to their attention, for example, from the extensive history of entomology in the war, now in preparation.

Thus, the M-day plans would be based on a very careful and complete analysis of the entomological lessons of the past war. M-day plans could then be kept up to the minute by making use of all new discoveries as they develop, with revision of the plans as often as scientific advances warrant. Here again the national entomological societies can greatly facilitate the work of Army entomologists by concentrating and funneling needed information to the latter, if so requested by the Army.

There should be effective effort to discover and secure vital knowledge that is not available.

In addition to information on new developments which the national societies could furnish the Army as they occur in the process of regular Federal, State and private work and research programs, specific research should be carried out on those particular vital problems of the Army which are unsolved, in the fields of insect physiology, taxonomy, ecology, and control.

No opportunities for encouraging this planned research should be overlooked. For example, the Army could support requests to Congress for funds for such research by agencies like the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture, and the United States Public Health Service. And, again, direct appeal could be made to the national entomological societies to stimulate its members to research on vital problems.

If, in the early 1930's, the Army—in anticipation of possible global war with consequent involvement in exotic insect-borne disease dangers—had requested civilian entomological, medical and engineering societies and agencies to work jointly toward the establishment of "entomological security," many of the disastrous encounters with these diseases absolutely could have been avoided.

Much progress has been made toward entomological security but far more remains to be accomplished if it is to be had for the entire earth, the logical goal. It would appear that the War Department would not be satisfied until all needed information on both a strategic and tactical level is at its fingertips for all of the entomological problems of the world of significant military importance.

This is a very large goal and much of this task can be accomplished only by civilian effort (for example, obtaining full information on the scores of species of insects of medical importance which are only found outside the United States). It is necessary that entomologists *in general* be educated to and kept interested in the needs of the Army in providing national security, and are convinced that the Army is truly desirous of civilian entomological cooperation in having its problems solved. If such an appeal is put across, then in any future emergency entomological service will approach perfection.

Administration and Supervision of Technical Activities

20. Biologist (entomologist), Ph. D., Reserve, Navy, commander:

The administration of sanitary work and research by medical men unfamiliar with preventive practices and lacking in research understanding led to much ineffective work. Too long delays were frequent. Much unnecessary, even harmful, work was undertaken.

21. Biologist (biochemist), Ph. D., Reserve, Army, captain:

In determining an individual's assignment, professional training and experience are more important than limited amounts of training in some military field which he had in the past. He has spent a large amount of time on the former, and only a little time on the latter.

Example: Before World War II, I was commissioned in the Engineer Reserve because I took ROTC in that branch. Later I did postgraduate work in biochemistry and bacteriology, fields not closely connected with engineering. When ordered to active duty, I was not assigned to any technical work, although there was supposed to be a crying need for biochemists and bacteriologists in the Medical Department. and some other branches. It was many weeks before I was able to get relieved from duty with Engineer troops and detailed to the Sanitary Corps.

The wartime "pool" system ought to be modified; it is a great waste of manpower to commission technical specialists, than to leave them in some pool for weeks or months with no work to do.

Example: In the Medical Department pool in Washington, D. C., in 1942, numbers of medical men, bacteriologists, entomologists, and other specialists, hung around all summer and into the fall without any particular duties. One

medical man (a capable individual in research) was kept on as a sort of "fifth wheel" until October 1943.

Standard bacteriological methods (and other technical methods) ought to be revised from time to time and ONE MAN (assisted by specialists), made responsible for the revisions.

Example: TM 8–227, Methods for Laboratory Technicians, was compiled in a great hurry in 1941, and many of the methods were unsatisfactory. Revision began in 1942 (I helped with some of it), but developed into a sort of football which was kicked about between various agencies and individuals of the Medical Department, as well as the National Research Council. Revision was not finished until a year after the war ended. The published manual has now appeared, dated 1946 on the cover and 1947 on the title page.

Bacteriologists (and other specialists) will be most useful to the Army if able to work in their special fields with a minimum of interruption.

Example: The Medical Department always claimed to be short of technical specialists, yet constantly interrupted their work with all sorts of time-consuming administrative duties (most of which could have been done by the Medical Administrative Corps) and with various training activities which had little bearing on the actual situation.

Adequate equipment is essential for work in bacteriology or anything else. It need not be elaborate, but must be efficient.

Example: In 1944, I was chemist-toxicologist in a Medical General Laboratory, supposedly "a medical unit of the very highest echelon." Nevertheless, there were only five reference books on chemistry provided by the tables of equipment, and none on toxicology. In training, we were not allowed to use even the inadequate material provided for routine clinical chemistry. It was kept cased so that we would not use it up or damage it. We had to work with odds and ends picked up here and there. No attempt was made to procure the special nonstandard items needed for toxicology until we were about ready to go overseas, when it was too late. (It is only fair to say that bacteriology (in contrast to chemistry and toxicology) was appreciably better equipped.)

Classification and Training

22. Biologist (bacteriologist), M. S., enlisted, Army, tech 3d grade:

Classification is not just an initial instrument in placing personnel in any organization, but is a constant evaluation of personnel. Unless this constant evaluation of personnel is carefully considered, no organization can function at its best, nor can the personnel give their fullest.

I suggest a pool of scientific men be made from which the needed professional men can be drawn. It seems that there was no trouble finding M. D.'s and D. D. S.'s. Why should there be trouble in finding other professional men? The main difficulty from my viewpoint seems to lie in classification of the enlisted men. I speak from experience since I worked for 11 months in the classification section of our unit while I was a clerk. There I saw many examples of poor classification. Ph.D's in biochemistry; lawyers, etc., as plain medical soldiers. Then I saw many examples ot complete disregard of professional background. Laymen were trained to do technical work, which professional men could have done. Of course, I am talking of the enlisted ranks. Please bear in mind that these views are from an enlisted man's observation.

Unfortunately many well-qualified enlisted men could not seek transfers to the proper branch of the Service. Not that they did not try, but because their

commanding officers would not release them. Classification should have the authority to place men in their proper branches.

23. Psychologist, A. B., draft, Army, first lieutenant:

The chief inefficiency in use of psychologists sprang from the late realization that they must be selected for assignment in their own specialty. Many men were assigned to service or combat duties who were potential or qualified psychologists because the situation at the time of their arrival in the reception centers, demanded, *at that moment*, say infantry or engineers. Later, often after a substantial portion of these were re-trained at great expense and shipped out as specialists in their units, there came a belated realization that trained psychologists were needed. Often little was left except marginal psychological material or men from allied fields (education chiefs) who were "trained" as psychologists.

The clinical psychology school I attended, for example, contained a very diverse lot of people who were assembled in last-minute orders to become "psychologists," while qualified personnel were serving somewhere else as everything from war bond officers to infantrymen.

One answer is *preclassification* of professionals before induction, with deferment until the Army is ready for them. Should be called on basis of Army's *need* rather than chance numbers which are supposed to be democratically "fair."

Another thing is the Army schools. Our clinical psychology groups should have been trained by top-notch professionals called in from civilian life for the task. We had men as mediocre as ourselves for instructors.

In my own case, I think I was unusually fortunate in getting into psychological work in the Army after only 6 months in service. It was through no *planning* on the Army's part, however. I was sent to an infantry division and became a sergeant in an intelligence combat unit. It was only through much back-door manipulation of the situation that I got into clinical psychology. Every effort was made to prevent this in 1942–1943 by the combat unit staffs. I was scheduled to become an artillery officer, for example, and only the efforts of a friend in division headquarters got my application for adjutant general's OCS, sent off secretly to AGO, who issued orders for my transfer.

Unless utilization of professional personnel is planned ahead and controlled at the top level before the persons concerned get into service, the exigencies of the immediate service needs in reception centers is bound to misassign them.

The other chief deterrent to efficient use of psychological service that I noted was the refusal to assign rank in proportion to the job called for in psychological work.

It is an axiom in the Army service that, no matter what a person's training and skills are, he is useless without corresponding rank. A competent man who is a private cannot effectively use his training in a special training unit, for example, as many less fortunate men than myself were forced to do.

Similarly a second lieutenant clinical psychologist on a general hospital staff sitting in conference on a patient with a group of doctors whose lowest rank is a captaincy cannot effectively operate in his field. His value tends to be identified with his rank and his opinions carry only as much weight as the insignia he wears.

24. Mechanical engineer, B. S., drafted, Army:

I spent approximately 42 months in the Army. In that time I saw service with the Corps of Military Police and with the Postal Service. Frankly, I must say that I had a relatively easy time. However, as a technically trained man, I believe that my contribution was negative.

25. Biologist (entomologist), M. A., direct commission, Navy, lieutenant (s. g.):

During World War II, no adequate basis existed by which military authorities could determine whether or not a man was qualified as an entomologist. To correct this situation it is suggested that the minimum requirements for entomologists be set up by a committee of well-known United States entomologists under the sponsorship of the A. A. E. E. This committee would establish a roster of entomologists. Men desiring to enter the military service as entomologists could submit their credentials to this committee. By this means the military authorities would be assured of the entomological qualifications of a candidate.

In time of war men with good general training and experience in agricultural entomology should qualify for entomological duty in preventive medicine as readily as specialists in insects affecting man. Also qualified entomologists should be released from other branches of the military service upon their own request when entomologists are needed.

26. Forester, B. S., enlisted, Navy, radio technician:

Foresters were generally misfits in military service because no one knew how to classify them or how to use their experience. Foresters in military service should be able to use at least some of their training and experience, as, for instance, aerial photograph interpretation, topographic mapping, supervision of any wood utilization program, fire protection planning for military establishments where natural fire hazards are involved, road pioneering, etc.

27. Biologist (bacteriologist), B. S., direct commission, Navy, lieutenant:

Classification by this Society should be made available to War and Navy Departments for use as a pool of technical men. Selection of these scientists to be made by joint Army-Navy-Civilian board to afford distribution of skills to all services. Civilian members of above board to be competent scientists of repute whose knowledge of field would enable them to correlate distribution of selectees' aptitudes to best channels.

28. Physicist, B. S., direct commission, Navy:

My training was used to an advantage, but by putting me immediately into physical research, rather than training me further to become an electronics officer, a good deal of the Governments' time and money could have been saved (although to my disadvantage).

I can recommend only what has already been well covered; i. e., better realization by military officials of the extreme importance of scientific research, and acceptance by them of the obvious fact that utilization of previously trained personnel rather than high powered, high velocity training of inexperienced (and often unqualified) personnel is a must.

Assignment and Utilization in Uniform

29. Biologist (bacteriologist), Ph. D., direct commission, Army, major:

During the last war there were numerous instances in which men—both officers and enlisted—were classified as bacteriologists but their training was not utilized. In most instances this was due to improper assignment on the part of the commanding officer of the unit to which the individual was assigned. For instance a Sanitary Corps officer with excellent training in bacteriology may have charge of insect control, and the entomologist have charge of serology. An enlisted man

may even spend four difficult months going through an Army Technicians School and then spend the remainder of the war as a truck driver. One could go on indefinitely with such examples.

The methods for correcting such mistakes must come from the Army itself and one method would be for the Army to establish a Personnel Corps made up of both officers and enlisted men. The members of this branch would be trained in job classification and personnel problems. It would be their duty to interview all individuals and classify them according to experience, education, etc.; then after classification it would be their duty to see that the individual was assigned and utilized as classified. To accomplish this last task it would be necessary to place a member of this Corps in each unit and make him responsible for the assignment of personnel and then make all requests for personnel channel through this Corps. In this manner it would be removed from the hand of the commanding officer, adjutant, first sergeant, etc.

30. Mechanical engineer (aeronautical engineer), M. S., drafted, Navy:

While in training at the United States Naval Training Center, San Diego, California, I went through the standard training course, but difficulties arose when it became necessary to find a suitable place for me in the Navy, since the Navy does not have any provisions for handling enlisted men with professional status.

The Navy did not have any suitable system established by which suitable use could be made of enlisted men with professional experience—as opposed to the recognition of persons without professional experience but with trade background, such as carpenters, mechanics, etc.

The Navy did not show an interest or desire to correct the above-mentioned fault in their system.

The only way in which an enlisted man with professional standing could obtain work in his own field was by his own initiative (this is not only evidenced by my own case but by several others which came to my knowledge).

The delegation of responsibility to carry out technical projects without suitable authority served to delay the completion of military projects and contributed to further inefficiency in the use of technical knowledge and experience gained in civilian life.

Based upon the above conclusions, which apply directly to the Navy but can be extended to all military Services, the following recommendations can be made:

1. That the Services include in their classification of enlisted men provisions through which enlisted men with professional experience, background and/or education can be handled and placed in positions where their knowledge can best serve the country and the military Services most effectively and efficiently in time of war or emergency.

2. That a new enlisted rating be made for engineering enlisted personnel in the Navy and Army who cannot become officers by reasons of not meeting the Service's physical requirements. The Navy Specialist "x" rating is only suitable for draftsmen.

3. That, in time of emergency, boards composed of qualified technical personnel, be set up to handle the cases and placement of men who have been inducted into the Service but who have professional status in the engineering profession.

4. That a system be set up to grant technically qualified men sufficient temporary authority to carry to a successful completion any project which may be assigned to them. This can be done by means of station orders, etc.

5. That, whenever possible, professional men be granted the rank of an officer. That, for persons unable to qualify for the rank of officer by reasons of physical disability, a special grade of warrant officer should be created into which they

can be absorbed. This would grant a certain amount of intellectual freedom and also freedom from the variety of menial tasks which an enlisted man is subjected to in order to impress upon him the lowness of his station.

I hope that the above comments will be helpful in setting up a suitable program for the better handling of engineering personnel who are inducted into the Services. If some of the above recommendations were put into effect I am sure that much of the bad feeling evident in men with professional standing, who have been in the enlisted ranks, would be eliminated by the knowledge that suitable channels of action have been provided for them and that their special abilities would be used in the most effective manner in any future emergency.

31. Physicist, Ph. D., Reserve, Navy, captain:

I feel that my experience and background in physics were used with 100 percent effectiveness in World War II. It put me in a position, when combined with my military status, to do a unique job in the organization and development of research in the Navy—a position which led to the production of a definite weapons program with less lost motion and with greater economy of manpower and material than was possible in most other arrangements—by application of physics to the needs of the Military.

My experience indicates that physicists should be relieved of all required military service in time of national emergency. I feel that it would be advantageous to be able to commission limited numbers in order that their technical competence might be backed by the necessary military authority to make them and their co-workers more effective in military matters.

32. Biologist (phytopathology), Ph. D., enlisted, Navy, lieutenant (s. g.):

When enlisting in the Navy, I notified the Office of Naval Officer Procurement of my professional training and experience and requested advice regarding possible utilization in the military Services. I was advised to seek a commission through the V-7 training program because no need existed for plant pathologists. I pointed out the possible use of pathologists in fruit and vegetable inspection and shipping work, but the Office of Naval Officer Procurement saw no application. As a result, my professional training was never utilized. In 1941, I applied for training in degaussing and was rejected because of a full program. In 1942, my request to apply my training in bacteriology, chemistry, and physics to hospital laboratory work was also rejected.

33. Geologist, M. S., drafted, Army, sergeant:

Assigned Chemical Warfare Service July 1945. Classified as EM specialist, but no use made of technical training. Assigned to duty Canal Zone November 1945, but assigned to work involving no technical training.

Geological training utilized as civilian with U. S. Geological Survey. Engaged in ground water studies for war plants and military bases, but no further use made of training after entry into armed forces in May 1945. Believe civilian specialists whose training has value for military purposes should be classified and ranked so that they might be of real service in the armed forces. For example, I should have been commissioned as an engineering officer assigned to water supply work. Believe that OCS schools are not the best way to grade and rank specialists such as physicists, chemists, geologists, etc. Writer knows of instances where grocery clerks became chemical warfare officers of high rank, and chemists (Ph. D.'s) served as corporals and sergeants in the field artillery. Such a classification system made for a tremendous waste in the war effort during the recent war. Writer believes that civilian scientists should be given a semimilitary status during war so that Ph. D. physicists, etc., could not be drafted as privates.

34. Chemist, M. S., Reserve, Army, captain:

My particular assignments in the war were examples of comparatively effective use of professional personnel. The administrative experience thus gained has contributed to, rather than decreased the usefulness of my present background.

On the basis of my own experience I believe that chemists should be utilized where necessary in the military service as officers rather than as civilian employees of the service concerned. Rank should be determined by qualifications and background of the chemist and promotions granted as in industry, on the basis of merit and the contribution made by the individual. This arrangement would have several advantages:

1. The individual would feel a greater responsibility for and interest in his work as a part of the organization rather than just "one of the hired help".
2. He would have some authority more or less commensurate with his ability and a recognizable standing in the military organization.
3. He would not be in the position of a civilian with superior qualifications forced to work under the supervision of less qualified men who happened to have held a Regular Army Reserve commission in normal times.
4. He would not be under the stigma of remaining a civilian while others in like status were publicly "serving their country."
5. Professional men as members of an armed services could be placed where most needed and transferred when necessary much more easily and conveniently than was the case with civilians during the last war.
6. More equitable pay rates for similar work would be established than was the case during the war.

35. Physicist, M. S., Reserve, Army, lieutenant colonel:

First, and obviously, do not take into the Army through induction anyone classified as a physicist who is, or can be, utilized in his own field. Anyone classified as a physicist who is called into the Army from the Reserve or National Guard should either be released from active duty for military-sponsored research or teaching, or else be assigned in a military capacity to military research programs or to a branch of the service in which his professional training and experience can be utilized.

It is believed that physicists who are also trained officers would be particularly useful in liaison positions dealing with problems common to the civilian physicists and the military agencies concerned. The military services should be screened periodically for physicists who are being used in routine positions, and whose services are needed in their own field either in a military or civilian capacity.

36. Geologist, M. S., direct commission, Air Force, lieutenant colonel:

Improvement in Army's assignment procedure to insure maximum use of its excellent classification methods. Peacetime study by G–1 to determine the optimum relations between civilian job classifications and military specialties. Close liaison between military geology unit of U. S. Geological Survey and geologists who are active or Reserve Army officers. Improvement of Army training of officers to teach more effective use by commanders of their general and special staffs.

37. Geologist, Ph. D., direct commission, Navy, commander:

Do not attempt to oversell geologists in war. Determine number of geologists and training required as specialists with armed services and Government bureaus. Recognize fact that many geologists during last war made excellent field officers and contributed more than if only their technical training was utilized.

38. Biologist (entomologist), Ph. D., Reserve, Army, captain:

Early integration of entomologists into the Medical Departments of both Army and Navy would be desirable. During the last war many of us spent years in other branches of the services where our professional training was not used. The development of a pool of entomologists with Reserve commissions would be desirable. Then in the event of an emergency, men who were interested in serving in the armed forces would be available for various entomological assignments.

39. Physicist, B. S., enlisted, Army, T/4:

The first two years of service found whatever training I had in physics almost totally wasted. It was only through the effort of nonmilitary authorities that I was finally able to get into work where my training could be utilized.

For better utilization of professional men in the armed forces, control over some should be taken from the hands of the military and placed in the hands of a civilian commission. This control should be complete and should allow for complete freedom of investigation by the civilian authorities.

The Organized Reserve Program

40. Biologist (entomologist), B. S., enlisted, Army, captain:

All foreseeable problems should have trained men assigned to them in a Reserve status, in order that they may keep up on the literature. Assignments during wartime should be made from a central pool by trained men, not by any classification officer. For instance, all entomologists should be listed in a central pool and subdivided by previous experience. Assignments from this pool should be made by entomologists, so that a man who knows something about mosquitoes would handle mosquito problems, or a problem in airplane dusting of swamps would be handled by a man who had done airplane dusting, not by some graduate student who had monographed the genus *Culex*.

41. Physicist, Ph. D., Reserve, Army, lieutenant colonel:

My physics work was not effective. Army should form a small group of Regular officers into a professional research group. Officers appointed should hold the Ph. D. Then form a research group of Reserve officers—also made up of men with broad training and experience in research. The Regular group to keep in touch with work in universities and industrial laboratories in time of peace and be prepared to get the Reserve group into the proper positions and at work with a minimum delay in time of emergency. Unless something of this nature is done, men with advanced degrees will refuse Reserve commissions. They saw too much waste of skills in the last war.

42. Physicist, Ph. D., Reserve, Army, major:

My training in physics was almost completely ineffective, even though I made repeated attempts to transfer into some phase of the military work that would utilize it.

Based on my experiences, one should have no connection with any Reserve military organization if he expects to have any application of his professional training in physics during a national emergency. Under present conditions of weapon development the military organizations should have physicists on their staffs, but I certainly do not recommend the procedure to any physicist.

43. Psychologist, Ph. D., Reserve, Army, lieutenant colonel:

Extremely little use was made of psychological training. Because of ROTC training in field artillery, all attempts to transfer to possible use of professional training were refused. Apparently little attempt at analyzing Reserve officers for best use during active duty in the emergency (was made).

44. Biologist (entomologist), Ph. D., Reserve, Army, captain:

Obtained commission in Reserve (Coast Artillery) upon graduation from college. In spring of 1942, tried to transfer to Sanitary Corps but was unable to do so. Upon separation received commission in Sanitary Corps because I refused to accept commission in any other branch.

Physical Qualifications for Service

45. Geologist, B. S., draft, Air Force, captain:

It is believed that my training in geology and engineering made me a more competent interpreter of aerial photos than were some of my associates who lacked that training. Although partially blind in one eye and unable (for that reason) to see stereoptically, my knowledge of terrain, maps, and natural features placed me on a par with my fellow interpreters, except in the interpretation of radio and radar facilities on *photos lacking distinct shadows.*

It is my opinion that the Services were inclined to arbitrarily set up nonessential requirements (such as physical, age, etc.) for technical men and, by rigidly and occasionally blindly adhering to them, lost to our country the services of many excellently qualified persons.

46. Physicist, Ph. D., direct commission, RCAF:

Full use made of my technical training with applications to both fields of astronomy and physics. As I was turned down in 1940 by the USNR when applying for a commission as my vision is not 20/20 without glasses (it is 20/20 when corrected), I could suggest that scientific personnel be granted some leeway in examination.

I can also state that the British system of assigning scientific advisors (with combat experience) to every higher commander was eminently successful—I was one.

APPENDIX II

NATIONAL ORGANIZATIONS AND SCIENTIFIC AND TECHNOLOGICAL SOCIETIES PARTICIPATING IN THE SCIENTIFIC MANPOWER STUDY

Biology:

National Research Council, 2101 Constitution Avenue, Washington, D. C., Office of Scientific Personnel, Dr. M. H. Trytten, Director, Division of Biology and Agriculture, Dr. John S. Nicholas, Chairman.

Agronomy:
- American Society of Agronomy.
- Soil Science Society of America.

Animal Production, American Society of.
Bacteriologists, Society of American.
Biological Chemists, American Society of.
Dairy Scientists: American Dairy Science Association.
Development and Growth, Society for the Study of.
Ecology: Ecological Society of America.
Entomology:
- The Entomological Society of America.
- The American Association of Economic Entomologists.

Foresters, Society of American.
Genetics: Genetics Society of America.
Horticulture: American Society for Horticultural Science.
Limnology: Limnological Society of America.
Mammalogists, American Society of.
Mycology: Mycological Society of America.
Nutrition, American Institute of.
Parasitologists, American Society of.
Physiology: American Physiological Society.
Physiologists, Plant, American Society of.
Phytopathology: The American Phytopathological Society.
Poultry Science: Poultry Science Association.
Zoologists, American Society of.

Chemistry:

American Chemical Society, 1155 Sixteenth Street NW., Washington 6, D. C. Mr. Alden H. Emery, Secretary.

Engineering, Civil:

American Society of Civil Engineers, Engineers Joint Council, 25–33 West Thirty-ninth Street, New York 18, N. Y., Mr. W. N. Carey, Secretary.

Engineering, Mechanical:

The American Society of Mechanical Enginers, Engineers Joint Council, 25–33 West Thirty-ninth Street, New York 18, N. Y., Mr. C. E. Davies, Secretary.

Geography:

American Society of Professional Geographers, School of Mineral Industries, The Pennsylvania State College, State College, Pa., Dr. George F. Deasy, Treasurer.

Geology:

American Association of Petroleum Geologists, Box 979, Tulsa 1, Okla., Mr. J. P. D. Hull, Business Manager.

Geological Society of America, 419 West One Hundred and Seventeenth Street, New York, N. Y., Dr. H. R. Aldrich, Secretary.

Mathematics:

American Mathematical Society, University of Pennsylvania, Philadelphia, Pa., Dr. J. R. Kline, Secretary.

Institute of Mathematical Statistics, Packham Building, University of Michigan, Ann Arbor, Michigan, Mr. G. W. Snedecor, Secretary.

Physics:

American Institute of Physics, 57 East Fifty-fifth Street, New York 22, N. Y., Dr. Henry A. Barton, Director.

Psychology:

American Psychological Association, 1515 Massachusetts Avenue NW., Washington 5, D. C., Dr. Dael Wolfle, Secretary.

APPENDIX III

PERSONNEL POLICY OF THE ARMY

(Circular 121, Department of the Army, 1948)

PERSONNEL POLICY OF THE ARMY

1. Purpose.—The Army personnel policy is predicated on the premise that the individual is the most important single asset in any army. It aims to clarify and improve the daily working relationships between each individual and unit by fully recognizing the dignity and importance of the individual so that the Army may operate as an integrated team in the National Military Establishment. Army personnel management aims to maintain an organization efficiently administered and effectively managed. This purpose may be implemented by—

a. Assuring the most efficient utilization of every man's abilities.

b. Providing opportunities for each man to attain the highest proficiency consistent with his capacity.

c. Providing every reasonable aid to improve his welfare.

d. Planning wisely for the future so that any necessary expansion will use all available manpower effectively with a minimum of disruption to the individual's economic life.

2. Command and organization.—To insure appropriate coordination and adequate control, command channels, as established, will be used to achieve effective personnel management. Tables of organization, organizational charts, and classification manuals are available to all so that each member of the Army may know his primary duties, to whom he is responsible, and the extent to which he must acquire further knowledge for promotion and advancement in career fields. Effective personnel organization requires that—

a. Authority be delegated commensurate with responsibility.

b. Specific duties and responsibilities be assigned and understood by each individual.

c. Criticism be of a constructive nature.

d. Communication channels be utilized from bottom to top as well as from the top down.

e. Commands or directives be issued through normal command channels, except in extreme emergency.

3. Effective administration.—*a.* The Army will continue to improve existing administrative records and to streamline the various functions so that both the individual and the service will profit thereby.

b. Adequate personal and service records will be maintained in a current status for every individual in the Army. Selections for special training, military and civilian schooling, promotions, assignments, and transfers, for example, will be based on a thorough knowledge of the individual's background and ability. Records of achievement, aptitude tests, interviews, demonstrated ability, physical fitness, and other selection techniques will be used to establish a competitive

basis for both military and civilian assignments, in accordance with sound career patterns. Consistent with his capabilities and the needs of the service, the desires of the individual will be given primary consideration.

4. Commanders' personnel management responsibilities.—*a.* Commanders must recognize the importance of *the individual*, as such, in the Army. A constant effort should be made to provide the individual with skilled leadership at every level; to capitalize on his aptitudes, interests, and talents; to stimulate his initiative; and to impress the lessons of loyalty and patriotism.

b. Effective personal relations in an organization can be satisfactory only when there is complete understanding and respect between individuals. Current information, full and complete explanations, frequent interviews, amicable relations, and full consideration of the individual's welfare are necessary aspects of sound management. Commanders of all echelons will—

(1) Strive for forceful and competent leadership which permeates the entire organization.

(2) Inform the troops of plans of action and *reasons therefor*, whenever it is possible and practicable to do so.

(3) Endeavor to remove on all occasions those causes which make for misunderstanding or dissatisfaction.

(4) Assure that all members of the command are acquainted with the procedure for registering complaints, together with the action taken thereon.

(5) Build a feeling of confidence and sympathy which will insure the free approach of subordinates for advice and assistance not only in military matters but for personal problems as well.

c. Personnel management, to be effective, must operate not only at the top level but at all echelons, including that of the most junior enlisted man having subordinates. Commanders will establish and implement personnel procedures in accordance with established Department of the Army directives that will—

(1) Place the right man on the right job through proper man and job analyses, efficient classification, and careful assignment.

(2) Stimulate his desire to produce through adequate incentives.

(3) Capitalize on his intelligence, interests, and aptitudes through suitable training.

(4) Utilize him fully on essential tasks.

(5) Insure individual's opportunities for professional development through intelligently planned and progressive rotation of assignments.

d. The broad principles stated herein are Army policy, established to implement military procedures which will sustain the rights and privileges of Army personnel without discrimination. Far-flung operations, world-wide conditions, and emergency situations of a highly diversified nature may require local variations. However, in every instance where variations are necessary, they will conform to the spirit and intent of policies outlined above for the Army as a whole.

APPENDIX IV

RESERVE OFFICERS

(Sec. V, Circular 127, Department of the Army, 1948)

V—RESERVE OFFICERS.—**1. Purpose.**—Preparation for modern warfare continues to make increasingly greater demands for more complex weapons and matériel; for increased applications of all fields of science, pure and applied; and for more highly trained scientific, medical, and engineering personnel to develop or design new weapons, to devise new uses for existent weapons and equipment, to safeguard the lives and health of the civilian populace as well as the uniformed forces, to operate the complicated technical machines of warfare, and to train others in their use. It is the purpose of this circular to provide a program for Reserve officers who are professionally engaged in research and development activities, in order to insure their optimum utilization in peace and war.

2. Objectives.—*a.* To establish a program for Reserve officers who are professionally engaged in research or development which will—

(1) Maintain the useful affiliation of this type of personnel with the Organized Reserve Corps.

(2) Provide peacetime assignments for these officers, enabling optimum utilization of their education, experience, and skills.

(3) Furnish mobilization assignments which will fully utilize their talents.

(4) Adequately prepare these officers for mobilization.

b. To establish adequate means for the selection of Reserve officers of this category to participate in this program.

3. Procurement.—Procurement of officers will be governed by the provisions of pertinent directives as published from time to time.

4. Organization.—*a.* In those military districts where there is a sufficient number of Reserve officers who are professionally engaged in research and development, the senior State instructor will recommend the formation of one or more Organized Reserve Research and Development Groups or Subgroups. This recommendation will include the names of those officers who are technically qualified and desirous of participating in this program, and will furnish sufficient pertinent information concerning each officer named to confirm his selection. This information will include—

(1) Educational attainment.

(2) Present occupation.

(3) Past civilian and military professional experience

(4) Bibliography of publications.

(5) Scientific and professional society memberships.

b. In addition, one officer will be recommended as commanding officer of the proposed group or subgroup.

c. The recommendations in *a* and *b* above will be forwarded through channels to The Adjutant General, Attention: AGPR–D, for final approval and authority

for activation of the Organized Reserve Research and Development Group or Subgroup. Upon receipt of final approval and authority for activation, the army commander will organize the appropriate Organized Reserve Research and Development Group or Subgroup.

d. A minimum of 20 officers is required for the formation of an Organized Reserve Research and Development *Group.*

e. In areas where there is an insufficient number of professional research and development personnel to establish an Organized Reserve Research and Development Group, qualified Reserve officers may be organized into Organized Reserve Research and Development *Subgroups,* attached for administrative purposes to an appropriate training group. The administrative procedure for the formation of these subgroups will be as outlined in *a, b,* and *c* above. Such subgroups will be composed of not less than 10 officers, except that in special cases the senior State instructor may recommend the formation of a subgroup of less than 10 officers.

5. Selection.—*a.* Final selection of qualified Reserve officers for participation in this program will be made by the Department of the Army.

b. A roster of officers assigned to Organized Reserve Research and Development Groups and Subgroups will be compiled by The Adjutant General annually as of 31 October, and will be distributed to all General Staff divisions; Office, Chief, Army Field Forces; commanding generals of area commands; and heads of technical services.

c. Reserve officers desiring to participate in this program may make application to the commanding officer of an appropriate Organized Reserve Research and Development Group; or if there is no appropriate group yet established, to the senior State instructor or unit instructor. Applications will include the information required by paragraph 4*a* and *b* and will be forwarded with appropriate recommendations through channels to The Adjutant General, Attention: AGPR–D.

6. Qualifications.—*a.* Reserve officers eligible for participation in this program must have the following professional qualifications:

(1) Possess at least a Bachelor's Degree, from a college or university accredited by one or more of the recognized national or regional educational accrediting associations

(2) Be engaged in a professional capacity in research and/or development work in a field normally associated with one of the physical, engineering, medical or biological sciences, including pertinent fields of psychology.

b. Professional employment in a field or activities more properly associated with routine or maintenance functions will not necessarily be considered as professionally qualifying an officer to participate in this program.

c. These requirements may be waived by the Department of the Army if the applicant's professional background and experience so warrant.

7. Security clearance.—*a.* The Research and Development Group, Logistics Division, General Staff, United States Army, and Office, Chief, Army Field Forces, may authorize an Organized Reserve Research and Development Group or Subgroup to receive such classified material, to include SECRET, as may be necessary for the accomplishment of any projects assigned to the group by the heads of technical services in coordination with the Research and Development Group, Logistics Division, General Staff, United States Army.

b. Unless otherwise specifically prescribed, the senior State instructor or the unit instructor will be responsible that this classified material is properly safeguarded as prescribed by AR 380–5 and other pertinent directives.

c. Security clearance of Reserve officers of such groups or subgroups, prior to receiving SECRET material, will be the responsibility of the senior State

instructor or the unit instructor. In accomplishing such security clearances, the responsible officer may request a check or investigation, as deemed necessary, from the appropriate army commander.

d. In making such security clearances, the procedure set forth in TM 30–218 will be followed.

8. Assignment.—*a. Peacetime.*—Reserve officers participating in this program will be given inactive duty assignments by the Department of the Army to Organized Reserve Research and Development Groups or Subgroups as prescribed in paragraph 4.

b. Mobilization.—When Reserve officers participating in this program are given mobilization assignments, such assignments will be to appropriate research and development installations or offices. These assignments will be made by the Department of the Army. Each assignment will be subject to review at any time by the using agency to determine that the officer concerned is still the best qualified officer available.

9. Training.—*a. General.*—Training will continue to be the responsibility of the Chief, Army Field Forces, within the policies established by the Department of the Army. The Research and Development Group, Logistics Division, General Staff, United States Army, and the heads of technical services will furnish technical assistance in the formulation of the program and the subject matter therein.

b. Inactive duty training.

(1) Orientation on the organization of research and development activities of the Department of the Army, of the Army Field Forces, and of the various technical services, including those boards and panels whose functions fall within the purview of research and development.

(2) Pertinent parts of courses from established schools and colleges of the armed forces.

(3) Review and editing of technical manuals and publications.

(4) Work on certain research and development matériel and nonmatériel problems as assigned by the head of the appropriate technical service in coordination with Research and Development Group, Logistics Division, General Staff, United States Army.

(5) Review or formulation of plans to assist research and development organizations, boards, or panels in accomplishment of their mission.

(6) Review or formulation of planning methods or the evaluation of proposed tactics, techniques, and organization.

(7) Assistance to service schools in revising or broadening their training programs.

(8) In view of the technical qualifications of the Reserve officers participating in this program, they will be encouraged to formulate their own training programs encompassing research and development problems or projects of interest to the Department of the Army.

c. Individual training.—Reserve officers whose professional standing and reputation are outstanding in their field may be utilized in an inactive duty status on a consultant basis by all agencies of the Department of the Army for technological assistance in the formulation of research and development plans and programs, the review of technological subjects, and the solution of technological problems. In such cases, credit will be given for a commensurate number of inactive duty training hours in accordance with section III, Circular 71, Department of the Army, 1947.

d. Active duty training.—Subject to the availability of funds, Reserve officers assigned to Organized Reserve Research and Development Groups or Subgroups, may be assigned to research and development agencies, schools, and boards of

the Department of the Army, the Army Field Forces, area commands, or the various technical services for active duty training upon request of the officer and approval of the establishment concerned; or upon request of the establishment and consent of the officer concerned.

10. Promotion.—Promotion of Reserve officers assigned to Organized Reserve Research and Development Groups will be governed by the provisions of pertinent directives as published from time to time.

11. Publicity.—Special effort will be made by all echelons to disseminate information contained in this circular through appropriate public relation facilities so that all details will be available to service, veteran, Reserve officer, professional society, college, and university publications.

[AG 326.21 (27 Apr 48)]

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